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A PIER 1,314 FT. LONG AND 150 FT. WIDE has just been constructed at the foot of 44th St., Brooklyn, by the Bush Terminal Co., whose purpose it is to develop a large ship and railway terminal and storage houses in the district named. Altogether five of these large piers are to be constructed. The new pier fronts on the new 40-ft. channel now being dredged by the U. S. Government, and will accommodate the largest vessels. The piers are constructed of timber, filled in with earth, and will be provided with railway tracks and elaborate machinery for handling freight and transferring cars from railway to floats. The distance between piers is 320 ft.

AN ORE PIER OF UNUSUAL MAGNITUDE is being constructed at the Spanish port of Almeria by the Alquife Mines & Railway Co., Ltd. The pier is located outside of and parallel to the Levant Mole, and will be used exclusively for loading iron ore. Its total length when completed will be 1,800 ft. The first 240 ft. from the shore is embankment between retaining walls, the next 600 ft. consists of eight masonry arches and three steel spans. The next 420 ft. consists of eight steel spans carried on steel towers, and then comes the ore pier proper, 360 ft. long. This pier has two pockets of 4,000 tons capacity each, which receive their ore directly from railway cars and chute it into vessels berthed alongside. The total cost of the work will be about $500,000, and the contractors are Alexander Finlay & Co., Ltd., of Motherwell, Scotland.

PLANS FOR A TUNNEL UNDER THE SEINE at either Tancarville or Quillebeuf, France, have been worked out by the well-known French engineer, Jean Berlier, who was employed for this purpose by the Chambers of Commerce of Rouen and Havre. The conditions which prompted this undertaking are stated as follows: Between Rouen and the sea there is no crossing of the Seine except by boat. Moreover, Havre is connected with the rest of France by only one railway line. The tunnel would supply the needed crossing and give Havre a second railway line. In his report Mr. Berlier advocates a twin tube tunnel, each tube being lined with cast iron and 5.4 m. (17.7 ft.) in inside diameter. He estimates the cost of such a tunnel at about $6,000,000.

THE NEW TROLLEY TUNNEL UNDER THE North River at New York City will have one of its twin tubes completed and ready for operation early next summer, according to newspaper statements made by Jacobs & Davies, of New York City, who are the engineers for the work. This tunnel is the old Hudson River Tunnel, whose partly completed bores are being finished. According to the statements published there remain only 1,200 ft. more of the north tube to be completed, and work is progressing at the rate of from 3 ft. to 13 ft. per day. The south tube has not been commenced. This is 5,100 ft. long.

A LARGE ITALIAN WATER-POWER ELECTRIC plant is being constructed near Brescia, in Northern Italy. According to the London "Electrician," the water is taken from the Caffaro River, forming the foundary between Italy and Tyrol. An up-stream station, which will be built later on, will supply 5,000 HP., while the station to be erected now in the Italian township of Bageline will make some 10,000 HP. available. In both stations three-phase current of 9,000 volts, 42 cycles, taken from the generator terminals will be transformed up to 40,000 volts. Current at this pressure will be transmitted to Brescia, some 40 kilos. distant, where it will be partly used for power and light distribution in the province of Brescia, and partly for operating large electrochemical works. The station, which is now in course of construction, has a water supply of 4,000 liters per sec., with a head of 254 meters, which corresponds to an effective turbine output of 10,160 HP. Five 2,500 HP. generating sets will be installed, each consisting of a turbine directly coupled to a three-phase generator and running at 315 revs. per min. Five step-up transformers, each of 2,340 kilovolt-amperes, raise the pressure to 40,000 volts, and after transmission it is transformed down to the working pressure by a like number of step-down transformers.

A SCHEME FOR UTILIZING THE COLORADO RIVER is outlined at some length by Mr. Arthur P. Davis, M. Am. Soc. C. E., Principal Engineer, Arid Land Reclamation Service, U. S. Geological Survey, Washington, D. C. The plan proposed is presented in popular form in the Los Angeles "Times" of May 22, 1903. In brief, Mr. Davis proposes high dams across the Colorado River, each to form an enormous storage reservoir, and to give elevation both to carry the water through high line canals and to provide sufficient velocity to carry a large amount of suspended sedimentary matter for deposition upon the irrigated area. Sluiceways would be built into the bottom of each dam, so the water and silt could be drawn from the various reservoirs. This sluicing out of silt, however, would affect only "the largest dimension and deepest part of the reservoir," which "will in all cases form an important part" of the storage capacity. The remaining area would gradually be filled with silt, and eventually the flow line of the reservoir would be lowered, and a large area of rich cultivable land made available. The dams would afford a large amount of power for use in mining and transportation, and in pumping water for irrigation. By building locks at the dam an electrically propelled boat service could be extended up the river from the present head of navigation. Navigation is also proposed on canals leading from the lower reservoir. Four dam sites are mentioned: One below Norton, Ariz.; one below Big Williams Fork; one at Bulls' Head: one in Black Canyon. The first two dams would be 150 ft. high; the third, 100 ft.; the fourth, 300 ft. The four dams would afford storage for "the width of the river channel, a length of 400 miles, and an average depth of perhaps 50 ft., or 1,060,000 acre feet." The estimated cost of the four dams is $15,000,000; canals and pumping machinery would bring the total cost to $22,000,000. Mr. Davis estimates that over 1,200,000 acres of land could be irrigated by the proposed works.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a butting collision on the Southern Railway, near Bryan, Ala, on May 27. Two freight trains going in opposite directions collided, and the wreckage caught fire and burned up. Seven trainmen were killed outright. The wreck is thought to be chargeable to non-delivery of orders on the part of an operator.

AN EXPLOSION IN THE JOVEITE FACTORY at Elmira, N.Y., on June 1 killed three men. The explosion was in the mixing room and probably was due to the picric acid, one of the ingredients, which before mixture with the nitro-phenol is more or less sensitive to shock.

AN EXPLOSION OF DYNAMITE occurred, May 18, on the reconstruction work of the Chateaugay R. R., fatally injuring two men and seriously injuring a third. All windows in Saranac Lake Village, three miles away, were broken.

THREE MEN WERE ASPHYXIATED IN A TAR tank at Delray, Mich., one of whom died. They were working for the Solvay Process Co. and were driving rivets to stop a leak in the tank. It is believed that the red hot rivets on the tarred surface of the tank generated cyanide gas, which poisoned the men, for there was no trouble until riveting was begun, and men had been in the tank for some time chopping away the tar.

TWO DAM FAILURES have been reported lately. On May 16 a dam under construction to form the Panguitch reservoir, near Panguitch and Circleville, Utah, gave way. The dam was being built for irrigation purposes by people in the vicinity. The failure was attributed to wave action during a heavy wind. The loss on account of the dam was estimated at $15,000, besides which much injury was caused by the escaping water.——A dam forming a reservoir for the supply of the works of the H. C. Frick Coke Co., at Lemont, Pa., failed on May 24, during or after a heavy rain and winds. A gap in the dam only 17 ft. and 25 ft. long was reported, but it is said that this let loose the contents of the reservoir, some 24,000,000 gallons.

A VIOLENT TORNADO WRECKED the city of Gainesville, Ga., on June 1, and caused the death of probably nearly 100 people. The storm came without warning and lasted only a few minutes, but within that time it destroyed a large number of factories, stores and houses, in the city and its surroundings and nearby towns. The greatest loss of life occurred in the wrecking of several large cotton mills, where the workers were buried under the wreckage of the buildings and machinery.

UNPRECEDENTED RAINS CAUSED GREAT FLOODS in Kansas, Nebraska, Iowa and parts of Missouri during the past week. In the preceding weeks, while the Eastern part of the country has been suffering from continued dry weather which threatened to result in great damage to crops, the region west of the Mississippi has had an excess of rain. The general heavy rains which began about two weeks ago and which at some points reached very unusual rates of rainfall caused floods of unprecedented heights in all rivers of the region mentioned. The Kansas River in particular rose to a great height, and the cities of Topeka and Kansas City, on its lower course, were flooded and vast amounts of property destroyed. At Topeka, Kan., probably about fifty persons were killed in the flood and in a great fire which swept over the flooded district where escape was difficult or impossible. At Kansas City, and its neighborhood, where fire also accompanied the flood, at least a score were killed; similar reports come from other points in the flooded area. The property damage and the losses from the destruction of factories, lighting plants, railway lines, etc., cannot yet be estimated.

THE RAINFALL AT SIOUX CITY, IA., was 11¼ ins. during the first 29 days of May, of which 2.27 ins. fell on May 29. In contrast, the total May rainfall at New York City was about 0.33 in.

FLOOD HEIGHTS IN THE MISSISSIPPI above Memphis are claimed to have been raised this year by the embankment approach to the Memphis bridge. When the bridge was first constructed the approach to it on the west side was made by a long wooden trestle. This was later filled in and it is claimed that the result was to retard the flow of water that formerly passed through the trestle at times of high floods. Surveys to determine the actual effect of the embankment are to be made under directions of Capt. E. W. Van C. Lucas, Corps of Engineers, U. S. A., and the matter is to be left to the Mississippi River Commission for decision by agreement of the parties in interest.

FUNDS FOR GOVERNMENT IRRIGATION WORK under the Congressional Act setting aside money received for the sale of public lands had reached a total of $7,730,000 at the close of the fiscal year 1902. Of this amount, $3,145,000 was realized in 1901 and $4,585,000 in 1902. The allotments of this money among the Western States ranges from $23,414 for Nevada and $49,135 for Kansas to $1,227,496 for North Dakota and $1,008,795 for Oklahoma. In addition to the last-named States, California, Colorado, Idaho, Montana, Oregon and Washington each receive over $500,000.

A LARGE SEAGOING HYDRAULIC DREDGE is nearing completion at Tacoma, Wash., and the "Tacoma News" gives the following particulars concerning it: The dredge is being built for the North American Dredging Co., and is designed to have a speed of 11 knots, and to cut her own clearance, making a channel 50 ft. deep by 200 ft. wide. The hull is 34 ft. beam, 160 ft. long and 16 ft. deep. The engines will develop 1,500 HP., and the dredged material will be discharged through a 26-in. pipe which may be 6,000 ft. long. The first work of this dredge, the "Pacific," will be the excavation of some 2,000,000 cu. yds. of material in Tacoma harbor. The cost of this dredge is said to be $180,000.

THE GREAT ROCKSLIDE AT FRANK, ALBERTA.

By Wm. Pearce.*

The village of Frank is situated in southern Alberta, on the Crow's Nest Pass division of the Canadian Pacific Ry., a few miles east of the Crow's Nest Pass. On the morning of April 29 last the village was visited by a disaster, the news of which was sent all over the civilized world. The first reports stated that a volcanic eruption had occurred, but investigation showed the calamity to have been due to a slide of rock from the adjacent mountain of a magnitude which has seldom or never been witnessed.

FIG. 1. DOMINION AVE. AND SIDE OF TURTLE MOUNTAIN AT FRANK, ALBERTA, BEFORE THE SLIDE OF APRIL 29.

The disaster at Frank occurred at 4.10 in the morning. Nearly all of those killed were asleep, and probably never knew what occurred. They were buried under such a mass of rock that death must have come instantaneously. Twelve bodies were recovered, being taken out of the edge of the slide; the balance were buried so deeply that there was no hope of recovery. In fact, owing to the pushing which incidentally accompanied the slide, it was impossible to know where to look for them. The total number killed was 66. Of these 8 were women, and 20 children, leaving 38 men. Of the killed, 21 were miners; the balance was engaged in various occupations, some farmers or ranchmen, others merchants, etc. Within the town of Frank itself only six buildings, miners' cottages, were destroyed, and one badly injured. Outside the village some ten buildings were covered by the rockslide and destroyed.

There was apparently no very great rush of wind with the slide except immediately in front of it. It is probable the slide was very deep in the center. The fanning out was by reason of following the line of least resistance, and a flattening which would take place naturally.

On the edge of the slide some very peculiar movements are discernible. Thus, a portion would strike a bank or ridge and would curve off to one side or another until its course would be deflected perhaps 120° from its original direction. This and the action which this deflection took in the way of throwing mud, gravel, sticks, and one thing and another, led many to believe that a large amount of this slide had been hurled through the air.

About 1,000 acres of land to the north and east of the Crow's Nest River (better known locally as the Middle Branch of the Old Man), was covered by the slide to a depth averaging probably 30 ft. In some places it was estimated to be 100 ft. deep. Directly on the toe of the slide are to be found rocks which come from the top of the mountain. Many of them had never turned over, as was evidenced by ferns and moss growing on them. There are one or two rocks which had traveled two miles from where they left the mountain side, and which have a bulk of nearly, if not fully, 1,000 cu. yds. The highest points of the slide have the larger rocks, the smaller ones being invariably found in the lower places. In one case was noticed a rock containing at least 1 cu. yd. thrown at least 100 ft. in front of the toe of the slide through the air, and landed probably 20 ft. higher than its point of leaving the slide. It was probably lying loose on the top of a large boulder which grounded, and the momentum of this smaller block carried it this distance ahead.

*Chief Inspector of Surveys, Calgary, Alberta.

The river channel was blocked to the depth of probably 50 ft. Fortunately, at that point the stream had a fall of possibly 70 ft. per mile, although the average fall probably does not equal 10 ft. to the mile. Thus the blocking caused no material damage by damming back the water. The stream is not a large one, and at the time of the disaster was probably not carrying over 100 second-feet. The stream even when in flood is not large, and probably does not exceed 1,500 second feet. Its drainage area above Frank is comparatively small. Thus danger from this source is not very great.

The Canadian Pacific Ry. track was blocked for about a mile and a-half, and that company is now busily engaged constructing a temporary line over the slide. The company was starting to change their line at that point, carrying it around adjoining the river channel, thereby obtaining better grades. If the contractor had been a day or two sooner on the ground, he probably would have had his party or a portion of it camped under the slide.

A small railway party which had been engaged in the construction of a road in from the Canadian Pacific Ry. line about a mile below Frank to the north, on Gold Creek, a distance of about five miles, was buried. Where the camp stood there is said to be about 75 ft. of rock. This branch line of road is owned by a French company, known locally as the Lille Colliery Co. They have their track covered by rock for 1½ miles to an average depth of 60 ft.

The slide after crossing the valley went up the opposite slope at least 400 ft., and probably 500 ft. above the river bed. The height of the mountain above the river bed, from which the slide came, is approximately 2,800 ft. The toe of the mass which broke loose and came down was probably 1,600 to 1,800 ft. above the bed of the stream. The detached portion left a perpendicular face estimated at 500 to 800 ft. in height. Its length is probably about 3,000 ft. and its width on the top 500 ft. As the highest point of Turtle Mountain was adjacent to the northeast face, and as it sloped from it towards the southwest at a dip of probably 45°, it will be noticed that the front portion of the slide was considerably higher than the rear. In addition to the rock that is piled up to the northeast of the Crow's Nest River, there is banked on the slope of the mountain on the opposite side of said stream, probably half as much more. The above will give some idea of the quantity of rock that moved.

The length of time that the disturbance took place is estimated at from one to four minutes by persons who witnessed the disaster. Many of them honestly declare that it was volcanic; that the action commenced where the toe of the slide now is; and that it was the vibration that made the mountain side break loose. Where the town of Frank stands there is very little soil overlying the sandstone, and there was no doubt very great vibration.

The Canadian-American Coal Co. were the chief

FIG. 2. VIEW FROM NEARLY THE SAME POINT AS IN FIG. 1, TAKEN AFTER THE SLIDE.

(The entrance to the coal mine which was closed by the slide is at the point marked X. In the background is the party of 17 miners who dug themselves out after 12 hours of imprisonment, being escorted back to the town.)

property losers. The houses destroyed at Frank were owned by them, and they lost their tipple, power house, horses, stables, and all the works; and not only the machinery installed, but a large amount of new machinery, to the amount, it is said, of $150,000, recently arrived awaiting almost immediate installation. This was lying near the

FIG. 3. VIEW OF TURTLE MOUNTAIN AND VILLAGE OF FRANK AFTER THE SLIDE.

mouth of the tunnel, and it came in the path of the slide and was totally destroyed.

At the time of the disaster there were only 17 men in the mine, and they all escaped, after being 12 hours imprisoned. These men were employed at repairs, looking after the timbering, ventila-

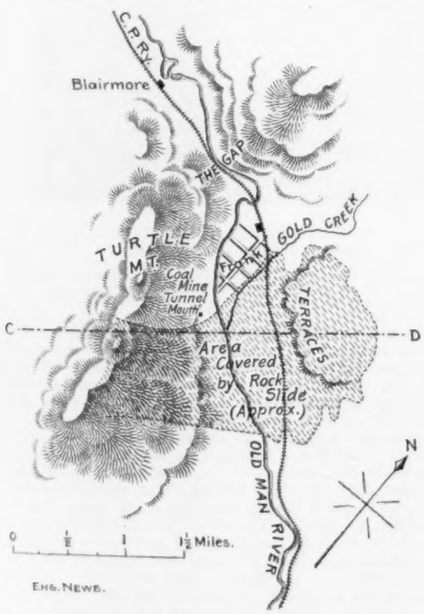

Fig. 6. Sketch Map of Rock Slide on Turtle Mountain, Frank, Alberta.

tion, etc., and not doing actual mining, as the disaster occurred at an hour when the miners proper were all out of the mine. Fortunately, among the men imprisoned in the mine there was one man who took charge of them, and who appears to have kept remarkably cool, and displayed a great amount of intelligence and good judgment.

As soon as he heard the shock he knew that something was wrong, and he went and hunted up all the men in the mine, some of whom were at the extreme end of the tunnel, 2,000 ft. further in from the entrance than he was. The total length of the tunnel was 6,000 ft. He gathered them together and they started to go out to the mouth of the tunnel. They found considerable coal had broken loose from the pillar immediately above the tunnel; and also that the timbers from side to side of the seam lying both on the floor and on the roof had either buckled or crushed. They had no difficulty, however, in working their way out until they approached to within 130 ft. of the mouth of the tunnel, when they found it was blocked. The leader then returned to where he had been when the shock took place, namely, about 4,000 ft. in from the mouth of the tunnel, and about 400 ft. above it. He found that whereas when he had left there was 8 ft. width where the coal had been taken out of the seam, the sides had come together so that he could hardly squeeze himself in. His object in returning to this point was he hoped he might possibly reach an air shaft which was a short distance away. Despairing of doing so, he then returned to near the mouth of the tunnel, and they dug out for some 30 odd ft. until they struck an air shaft. Fortunately this air shaft was not large, and struck the tunnel about 70 ft. from the surface; the rocks in it were not so large but that they could handle them. They were able to take them out and thus reach the outside, which they did about 12 hours after the accident occurred. In the meantime, their friends outside had despaired of ever seeing them, and were afraid, on account of the rock coming down, to approach this portion of the slide.

The coal seam on which this company was working has an average width of about 14 ft., and in some places, owing to folds, had a width of 30 ft. It kept its course remarkably well. The tunnel was taken out to the full distance of the average width of the seam and had a height of probably 8 ft., well timbered. Immediately above this tunnel there was a pillar of coal 35 ft. wide left with chute holes through it every 30 or 40 ft. Above that, the greater part of the coal was taken out up to the surface. The depth of coal lying over this pillar, a short distance in from the mouth of the tunnel, was 400 ft.; and at 4,000 ft. in, it was 800 ft. The rockslide did not extend beyond where the coal had been taken out. This coal, owing to the upthrust of the limestone in past ages, had been thrown up until it was 3° beyond the vertical. This coal company commenced operations about two years ago, and for the past year has had an output of from 600 to 1,000 tons per day. Nearly if not all this output has been taken by the Canadian Pacific Ry. for locomotive purposes, and the railway has been greatly inconvenienced by this source of supply being so suddenly cut off.

It is understood that the coal company purposes resuming operations. If the tunnel can be repaired, it will be used for access to and out'et for the coal lying to the southeast, beyond the slide. In addition, it is the intention to sink a slope or shaft in Frank adjacent to the railway, and go further down on the same seam and mine therefrom.

No tests have as yet been made to ascertain how much further down this seam holds its present dip. It is evident that it changes eventually, and in course of time finally assumes a horizontal, and then takes a reverse upturn. This field is peculiar in that respect, and consists of several seams varying from 4 ft. to upwards of 20 ft. in thickness, and lying parallel to and at no great distance from each other, so that they all can be readily attacked from one point. It is claimed to be part of the same field lying to the west of the summit of the Rocky Mountains, in British Columbia, known as the Crow's Nest Pass coal field. If that contention be correct, then it undoubtedly follows that it is a portion of the greatest coal area known, not only in the total thickness of seams, but in the area covered by it.

For upwards of a year after mining operations were commenced here, the naked light was solely employed in the mine. Since then gas has been struck, necessitating the use of the safety lamp. A few minor explosions have occurred; nothing, however, very serious.

Calgary, May 15, 1903.

Since the above was written the report has reached me (and I believe it to be reliable), that Messrs, McConnell and Brock, of the Canadian Geological Survey, who are examining the mountain, have given out alarming reports regarding the peak lying to the northwest and adjacent to the recent slide; that recent and alarming fractures are manifesting themselves behind this peak which leads them to the conclusion that it will come down shortly. It is also reported that they have advised the movement of the town site of Frank for some distance.

The first alarm with reference to the probability

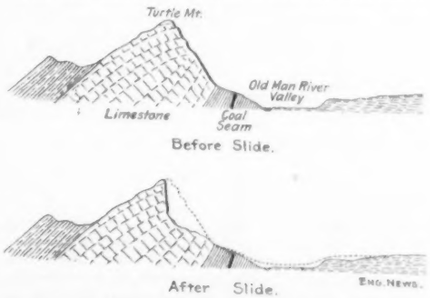

Fig. 7. Sections of Turtle Mountain Before and After Slide (on Line, C. D., Fig. 6).

(The geological structure of the affected portion of the mountain is shown by diagrams as an over-thrust and fold of the carboniferous limestones upon the upturned edge of the coal bearing cretaceous rocks. Thus the great mass of limestone is leaning forward upon abutments of the softer cretaceous shales and sandstones. This structure and contour is very common in the Canadian Rocky Mountains proper. The remarkable point is that slides of similar character are apparently rare; for if they had occurred, the evidence would still be present for centuries.)

of further and disastrous slides arose out of the fear that this peak might come down. The examinations then made, however, led to the conclusion that there was no danger at this point, but that there was danger from material in the rear of the first slide. Fear of trouble from this source seems to have passed away, however, the slides or breakouts having been of minor importance.

If, however, the peak now overhanging the town comes down in a large mass, it will probably

form an avalanche about a quarter the size of that first, and if it takes a course parallel to the first, most, if not all of Frank will be buried. It may happen, however, that its course may be across the former slide, or it may come down in such small portions that little or no damage will ensue.

The condition is particularly harassing and there seems to be nothing to be done but to watch and wait. The jar which took place from the first slide, owing to the configuration of this mountain, may have caused fractures which may extend for a very considerable distance from it, and it may take a considerable time before all disturbances caused by the first slide cease.

OFFICIAL INVESTIGATION OF THE FRANK DISASTER BY THE GEOLOGICAL SURVEY OF CANADA.

Immediately on receipt of the news of the disaster at Frank, Alberta, the Geological Survey of Canada commissioned two of its staff, Messrs. R. G. McConnell and R. W. Brock, to investigate the occurrence. Through the courtesy of Hon. Sir Wm. Mulock, Acting Minister of the Interior, and Mr. J. F. Whiteaves, Acting Director of the Canadian Geological Survey, we have been furnished with a summary of the preliminary report on the disaster, submitted by Messrs. McConnell and Brock, and print it in full as follows:

Turtle Mountain, the scene of the late disastrous rock avalanche, forms part of the most easterly or front range of the Rocky Mountains. It is a long narrow ridge with steep slopes on both sides surmounted by a number of rock peaks, the highest of which have an elevation of rather more than 3,000 ft. above the valley of Old Man River, or 7,400 ft. above the sea. Close to the foot of Turtle Mountain, at the point where Gold Creek enters Old Man River, is situated the town of Frank, an important coal mining center on the Crow's Nest Branch of the Canadian Pacific Ry.

The base of Turtle Mountain consists of beds of cretaceous shales and standstone; the precipitous upper portion consists of beds of Devonian limestone, the line of separation being the plane of a thrust fault, along which the limestone has over-ridden the cretaceous rocks. During this process the lowest beds of the "limestone" are highly contorted and crumpled.

In addition to the dangerously steep slopes, the shattering due to faulting and the easy separation of rock slabs along bedding planes, Turtle Mountain was further weakened by several sets of jointing planes which traverse it in various directions.

At dawn on the 29th of April a great slice of Turtle Mountain, one-half a mile long, over 2,000 ft. in height, and of great thickness, including the main central peak over 3,000 ft. above the valley, precipitated itself with terrific violence into and across the valley below, overwhelming everything in its course. The debris, consisting of fragments of limestone, together with sediments ploughed up from the beds of Old Man River and Gold Creek, now covers the valley to a depth of from 5 ft. to over 50 ft., over an area of two square miles. In its movement the debris resembled a fluid, flowing across the valley a distance of two miles and mounting the terraces on the opposite side of the valley to a height of 450 ft. above the Old Man River bed. About 70 lives were lost and much property was destroyed.

The disaster was due to a combination of causes, cumulative in their effects. The chief of these was the structure and condition of the mountain. Exceptional atmospheric conditions were also important factors. The precipitation during the last few years has been abnormally heavy. The days preceding the slide were excessively hot, causing rapid melting of the snow on the mountain, and allowing this water to find its way into the numerous joint planes and fractures. The night of the disaster the temperature fell to zero, causing all water to freeze and expand. The mountain was further weakened by opening up large chambers in the Canadian American Coal Co.'s mine, directly under the foot of the mountain.

The steep walled summit between the remaining north and south peaks is very badly shattered, as the result of the shock received during the slide. The south peak for 100 yds. back has dropped bodily 20 ft., and is traversed by open fissures, from a few inches to 20 ft. wide. The greatest movement has been in the central area between the two peaks. This is completely severed by gaping fissures into blocks which have tilted forward 10 to 20° from their original position, some of them dropping in the process 100 ft.

Numerous fissures extend down the shoulder, running west from the north peak for at least 500 ft. The shoulder of the mountain running east from this peak and which frowns down upon the town is very steep. To its solidity Frank and its inhabitants ower their preservation. It withstood the concussion of the breaking away of the mountain mass, and, acting like the side of a funnel, prevented the loosened material from spreading over the town. The mouth of the mine tunnel and the cottages at the south end of the town are threatened by the loosened masses on the North Peak.

The chief danger is apprehended from the fissures behind and west of the North Peak, for the safety of the town depends upon the stability of the protruding shoulder. To all appearances it is still secure; but the fractures which were found 500 ft. west of the peak and which on account of fresh snow could not be followed northward may extend so far in this direction as to loosen the whole of this shoulder of the mountain. If the town is to remain inhabited in its present position, these northerly fissures must be closely watched. They are not likely to open out or extend suddenly, and for this reason no immediate danger to the upper portion of the town is feared. If, however, any signs of slipping in the fissures some distance back of the face of the North Peak are detected, the town ought to be at once evacuated.

The fractured zone surrounding the former break is bound to fall away, but whether it falls gradually and in comparatively harmless blocks, or in large destructive masses, depends upon future conditions which cannot be foretold. The town of Frank might possibly exist on its present site uninjured for ages. But the fact that the threatening shoulder withstood the first slide is no proof that it is too solid to fall. The same conditions exist on the North Peak and this shoulder to-day as obtained on the central before it fell. A succession of seasons with unusual precipitation and rapid temperature changes, a slight earthquake shock or the closing of the chambers in the mine after the coal has been drawn, perhaps long after the inhabitants have lost their dread of the mountain, may give the impulse which will dislodge this mass and start it on a career of destruction. Since this possibility must always overhang the town, it would seem advisable to move it a short distance up the valley beyond the reach of danger.

FIG. 4. SOME OF THE ROCKS WHICH CAME DOWN WITH THE SLIDE.

FIG. 5. VIEW NEAR THE LOCATION OF THE FORMER MINE ENTRANCE, SHOWING OLD MAN RIVER.

(At the point marked X the 17 miners finally escaped after driving a 35-ft. shaft upward from the main tunnel. At the point XX, a rescue party dug all day in the hope of reaching the miners.)

THE MANUFACTURE OF CEMENT FROM MARL AND CLAY.*

By Henry S. Spackman, M. Am. Soc. M. E.†

The chemical elements necessary for the manufacture of Portland cement are lime, silica, and alumina, the last two being generally supplied by some form of clay or shale, the average ratio being one part clay to four parts carbonate of lime. In the United States the lime used in the manufacture of Portland cement is found in several forms, which may be classified under three general groups, argillaceous limestone, marl, and limestone, the latter group being capable of considerable subdivision.

Considering these in the order of their relative importance in the cement industry, the argillaceous limestone is easily first, although its supremacy is threatened, the output decreasing from 72% of the production of the United States in 1900 to about 61% of the estimated production for 1903. The principal deposit of this material is found in eastern Pennsylvania and New Jersey. The most eastern development is at New Village, where the Edison Portland cement works are located. The Vulcanite and Alpha works are a little south and nearer the Delaware River. The next development is at Nazareth, where a number of works are in operation and in course of construction, and the deposit can be traced across the country to the Lehigh River at Siegfried. Here are located the various works of the Coplay, Atlas, American, Lehigh, Lawrence, Whitehall, and Bonneville cement companies. There is no development of the deposit between here and the works of the Reading Cement Co. at Molltown, which

*Extract from a paper in the Proceedings of the Philadelphia Engineers' Club for April, 1903.

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is probably due to the fact that there are no adequate railroad facilities. From the works of the Edison Company to those of the Reading Company is a distance of about fifty miles, and, with the exception of the eastern end, the bed as developed does not appear to be over three or four miles in width. In appearance the argillaceous limestone resembles slate, and in chemical composition it varies within the following limits:

	Per cent.
Silica (SiO_2)	10.00 to 19.00
Alumina and Iron Oxide ($Al_2O_3 + Fe_2O_3$)	4.50 " 8.00
Lime (CaO)	38.00 " 48.00
Magnesia (MgO)	1.00 " 2.00

The next in order of output is limestone and clay, large works manufacturing Portland cement from these materials being located in New York, Ohio, Illinois, Virginia, Indiana, Missouri, and other states, all erected in the last four or five years, forcing marl cement from second place in 1902.

The last in the present order of output, but probably second in amount of capital invested and men employed, is marl. Perhaps a fourth should be added, furnace slag, from which considerable cement is being manufactured. Slag cement is manufactured in two ways: One method is simply a mechanical mixture of slag with hydrated lime, and the cement so manufactured is more correctly a puzzolana. By the other method a true Portland cement is produced, the slag being treated as a low-grade limestone, to which sufficient lime is added to secure a correct analysis, the raw materials being ground, mixed, and burned the same as for Portland cement.

The mechanical equipment of a cement plant varies with the raw materials used, each requiring a different treatment; but the general principle is the same, the object being to secure a fine grinding and thorough mixing of the raw materials perivous to calculation.

In the dry process which is used for argillaceous limestone, limestone and clay, and slag, you have as a rule hard materials which are fairly constant in their chemical composition and carry comparatively little moisture, while in the wet process which is used principally for marl, the materials dealt with are soft in character, often semi-liquid, carrying, as they come from the deposit, from 40 to 50% of water, and, with some methods of dredging, more. After calcination there is no great difference in the nature of the clinker, and the finishing departments of the different types of mills would be interchangeable.

Marl is of organic origin, the deposits being found in low lands, marshes, and the bottoms of lakes. In texture it is smooth and soft, varying in consistency from that of putty to that of river mud. While the greater majority of the shells are entirely decomposed, about 90% of the marl under ordinary conditions being found fine enough to wash through about a No. 100 sieve, some of the shells still retain their form. The majority of these resemble the ordinary snail shell in appearance, and vary in size from 1 and 2 ins. to those that are almost microscopic. In addition to these are found the shells of the fresh-water mussel, apparently of more recent date, which are sometimes as large as your hand. I submitted some of the shells taken from a deposit in Michigan to the Academy of Natural Sciences in Philadelphia, and Mr. H. A. Pilsbry wrote me in regard to them as follows:

> The shell-fish mentioned in your letter as found in a marl deposit in Michigan—viz., Planorbis campanulatus, Planorbis parvus. Limnœa stagnalis, Limnœa humilis, Physa ancillaria, Amnicola lustrica—are all still existing as living species. The marl in question is doubtless a comparatively recent deposit occupying the bed of a post-glacial lake or pond. Similar deposits occur in Northern New Jersey, where the beds of post-glacial ponds have become filled with calcareous material, largely molluscan shells.

The cooler climate and great number of ponds and lakes which followed the glacial period favored the multiplication of fresh-water mollusks, which at that time were evidently more abundant than at present, now that the vast majority of these ponds have become extinct by cutting down of streams to their beds and diminished rainfall, etc. However, the same shell-fish may still be found in many Michigan lakes to-day. As a general rule, it requires some search to find them, except in early spring and in the fall, when they are abundant enough in suitable places.

I have never observed any living specimens in the deposits examined, except a few of the ordinary fresh-water mussel.

In northern Ohio, near Sandusky, the marl deposits are of a different character, being largely of a chemical origin formed by the crystallization and deposit of lime through evaporation of the water which overflowed the low lands in periods of flood, etc. Springs in this neighborhood, which come up through the clay subsoil, carry a high percentage of lime, in some instances as high as 40 grains to the gallon. Large pieces of considerable hardness are frequently found, and these are known locally as prairie rock or petrified marl, and they resemble coral in their general appearance. On breaking pieces of this rock, the outline of rushes and water plants can be followed, which have apparently been incrusted during the process of crystallization and afterward decomposed, leaving in the travertine a cast of the plant. These stones are found in conjunction with granular marls, and are often of considerable size. I have only seen marl of this character in the vicinity of Sandusky, but there are deposits in New York state and elsewhere. In the organic marl deposits small quantities of travertine are found, generally under water and in shallow places, the precipitation being probably due to chemical action caused by plant life.

The deposits of marl vary in size and depth and in many instances are covered with several feet of muck. The mollusks, from the shells of which the marl is formed, must have been very abundant at the time of the formation of these deposits, as myriads of shells would be required in their formation, and the conditions immediately following the glacial period must have been exceptionally favorable for this form of life. They would appear to have flourished best in shallow waters, and it will generally be found that where the water is over 30 ft. in depth there is no marl under it, although fluctuations in the depths of the lakes may cause this rule to be departed from. I have observed that almost all of the lakes have an old beaver dam at the mouth, which at a later period had been reinforced by the dams of the lumbermen, which are now falling rapidly into decay. From the appearance of the deposits I would imagine that the various species of mollusks flourished along the edges in the shallow water, and gradually encroached on the lake itself, although it is possible that through the work of the beavers already mentioned the shallow lakes were gradually increased in depth and the marl deposits built up in this manner. With the exception of the presence of vegetable matter near the surface, there is no apparent difference in the analysis of marls taken from the swamps and low lands and from the lakes, where it was covered from 1 to 10 ft. with water.

The deposits vary in depth from a few inches to 30 ft., but should average at least 10 ft. for profitable working. The surface above low water and shallow portions of the lakes are generally covered with a vegetable growth, the peat and muck running from a few inches to several feet, and this has to be stripped before the marl is excavated. If the water is over 2 ft. in depth, the marl is generally clean.

There are few lakes or swamps in Michigan, northern Indiana, and the various portions of Canada bordering on Lake Huron, Lake Erie, and Lake Ontario, that do not contain marl to more or less extent, and I know of one deposit in Lake Huron itself. This deposit in Lake Huron is rather curious and is located a few miles north of Alpena. It has formed between a small island and the main shore. Drifting sands have practically closed the channel at one end, and the entire bay inside was filled with marl to a depth of about 10 ft. The marl, however, was very soft, and an oar stuck upright in it would sink through it by its own weight. While the shells from which the marl was formed were practically pure carbonate of lime, the chemical composition of the marl varies, due to the amount of vegetable matter it contains, and also to silica, which appears to have been blown in by the wind in the form of sand. Sometimes the sand is found in layers and at other times it is mixed through the marl itself. Its presence does not seem to have been caused by the wash from streams feeding the lakes, as the marl is found to be as pure, if not purer, at the mouth of streams emptying into the lakes, as in the other parts. While the vegetable matter does not directly affect the quality of the cement produced, as it is burned during calcination, it affects the value of the deposit commercially, as marl high in vegetable matter requires more fuel in its calcination and a greater bulk of marl has to be handled. If the sand is found in any large quantities, say over 3%, it is very objectionable, as, unless finely ground, it will not combine with the lime during the passage through the kilns, and, when finely ground, it requires a higher temperature to secure combination with the lime. Marl varies in its chemical analysis considerably, but for the successful manufacture of cement it should be within the following limits:

	Per cent.
Silica (SiO_2)	00.00 to 3.00
Alumina and iron oxide ($Al_2O_3 + Fe_2O_3$)	trace " 5.00
Lime (CaO)	45.00 " 56.00
Magnesia (MgO)	00.00 " 1.50
Sulphuric annydride (SO_3)	00.00 " 1.00
Organic matter	00.00 " 5.00

Marl deposits are plentifully scattered throughout the states bordering on the Great Lakes and in Canada, the eastern limit seeming a line drawn from Syracuse, N. Y., to about 100 miles east of Kingston. The western line extends into Illinois and up into Wisconsin, the southern limit being about 200 miles from the Great Lakes. On the north, in Canada, marl is rarely found at a distance of over 100 miles from the Great Lakes. I do not know of any deposit north of Lake Superior.

At all the larger mills the marl is excavated by mechanical means, some form of dredge or steam shovel being used. Marl is transported to the mill in various ways. If the surface of the deposit is above water and sufficiently firm, tracks are laid and cars are used; but if soft and covered with water, it is either pumped direct from the dredge to the mill or loaded into scows, in which case it is generally pumped from the landing to the mill, the method of handling varying with the conditions at each plant and the ideas of the designer.

The first mills built to manufacture Portland cement from marl and clay in the rotary kilns attempted the preliminary drying of the raw materials before grinding and mixing, but the results, so far as I can learn, were not satisfactory, due possibly to the fact that when these earlier mills were built, the cement industry was in its infancy and mechanical devices for its manufacture were not so fully developed as at the present time.

The question of drying the marl previous to the manufacture of cement is again being taken up, and I understand several mills are being designed on this principle, and one or two small ones are in operation. While there is no question in my mind as to the mechanical practicability of the drying of marl as the first step in its manufacture into Portland cement, I question whether it will be found as economical as the wet process, or will ever be commercially successful, and await with interest the results in a large mill now being built near Bay City, Mich., where I understand it is proposed to dry the marl at the deposit, ship it a considerable distance by rail, and then manufacture it into cement. The conditions at this deposit, however, are more favorable for the success of the experiment than any other I have ever seen, as the lakes in which the marl is found are so located that with comparatively little work the outlet streams can be lowered and the water drained from the lakes. The deposits were examined by the writer's firm some years ago, and it was suggested that the outlets of the lakes be lowered, a channel cut the entire length of the lake, from which others would run at right angles to the shore, and that in this condition it might gradually dry out.

A rough experiment was made to determine the effect of drainage of the marl. A considerable quantity of marl was piled in a room, the temperature of which was about 70° or 80° F., but the moisture was lost very gradually. After two weeks a sample was taken from the center of the pile, and on the moisture being determined it was found to contain 32%, the marl originally carrying about 50%, and I question whether by any system of drainage the moisture in the marl could be reduced much below 30%.

In the manufacture of cement from marl and clay it is necessary to add a considerable amount of silica and alumina, which is generally furnished by clay. For the wet process this is preferably plastic in character, and should be low in magnesia and lime and free from sand and pebbles, the combined iron and alumina in the clay being from one-half to one-third of the silica.

In the vicinity of marl deposits there is generally an abundance of clay, but it is difficult to find a deposit suitable for the manufacture of Portland cement, the majority carrying an excessive amount of magnesia, and where the magnesia is low there is apt to be an undesirable percentage of unavailable silica present in the form of sand. A number of mills started without giving the clay supply careful consideration, and are now compelled to bring their clay from Ohio.

Shales are found in Michigan which are of good chemical composition for the manufacture of cement, but I know of no plant which is using them for their clay supply.

Turning to the mechanical construction of a marl plant, the first problem that confronts the designer is the excavating of the marl and the delivery to the mill. This has been treated in several ways, continuous bucket dredges, dipper dredges of the clam-shell or the orange-peel type, pneumatic or hydraulic dredges all being used, but the latter process has not been found as successful as the other, owing to the large percentage of water brought up with the marl and the difficulty of separating the muck and other impurities from the marl. In some plants the marl is dredged and submitted to the preliminary preparation on the dredge, the marl being afterward forced through a pump line to the mill. Probably the most successful machine for the preliminary preparation of the marl is one resembling a mammoth sausage grinder, which in its principle is identical with the "Universal" meat-chopper. The machine consists of a hopper of sufficient size to receive from 1 to 2 cu. yds. of marl at a time. Underneath this hopper is a powerful screw conveyor which forces the material against a perforated plate, the holes in the plate being about ½-in. in diameter. The soft marl is forced through these holes, while the grass, roots, stones, etc., are discharged from the bottom.

I have had no personal experience with the pumping of marl from the dredge to the mill, but understand that the most successful device is a double cylinder with compressed air, the marl itself acting as a piston, the device consisting of two tanks which are alternately filled and emptied. After the tank is filled, the compressed air is turned on and the contents forced into the pipe line. In the mills where I have been connected with the design, the conditions have favored the handling of the material in cars, as the greater portion of the marl deposits were above water. Tracks were laid out on the marsh and the cars run directly to the dredge, a mattress of brush being used on the softer parts. On reaching the mill the marl is dumped into a separator or pugging conveyor, thoroughly breaking it up; the marl, which is now in a semi-liquid state, being about the consistency of grout, is stored in tanks or concrete pits. The clay, which is generally brought from some distance, is then added to the marl in correct proportions. It has been customary to dry the clay, grind it, and mix it with the marl at the pug mill, but in the mill of the Detroit Portland Cement Co., which

has just been started, a departure was made and the drying omitted, the two materials being reduced to a slurry separately.

On delivery at the mill the clay is first passed through a disintegrator and then into a pugging conveyor, where sufficient water is added to bring the clay to about the same consistency as the marl, and the clay is run to storage tanks, from which it is pumped with the marl into the mixing tanks, the proportion being roughly 1 cu. ft. of clay to 4 cu. ft. of marl. In the mixing tanks the slurry is subjected to thorough agitating, and the slurry is then ground to such fineness that 95% will pass a No. 100 sieve.

The handling of the raw materials after delivery to the mill is done by pumps, three types being in use, cylindrical pumps, centrifugal pumps, and compressed-air pumps, as previously described.

For grinding the marl the wet tube-mill has been most generally used, although in some of the Canadian mills which I visited this fall millstones were used with excellent results. After grinding, the slurry is stored in large tanks, where a final analysis is made, and if necessary the mix is corrected. From these tanks the slurry running from 40 to 50% of solid matter is pumped directly into the kilns, where it is dried by the waste heat, this drying taking place in the first 20 ft. of the kilns. Kilns for burning by the wet process are generally made longer than those used in the dry process. The stack temperatures in the wet process are considerably lower than in the dry process, and operation shows that the calcination of the slurry consumes considerably more coal than in the dry process. I am of the opinion, however, that this increased coal consumption is not entirely due to the amount of water in the slurry, but to the more refractory character of the raw materials, and to the decreased production. In one mill some experiments were carried on to determine stack temperatures in connection with the consumption of coal, and it was found that with a stack temperature of about 400° F., the best all-around results were obtained. In the dry process the stack temperatures run from 800° to 1,200° F., and, if the kiln is being forced, even higher.

The use of powdered coal in the burning of cement has now become almost universal, and with the exception of one or two small mills in California and Texas, oil has been entirely superseded. One mill is operated on natural gas; but I have been unable to secure any data as to capacities and outputs.

In ordinary practice the burning of cement by the wet process is more expensive for two reasons: First, there is an increased consumption of at least 50 lbs. of coal per barrel of cement produced, and a decrease in production per kiln of about 50%. While some mills claim to be producing by the wet process 125 to 135 barrels per kiln per day, I do not think the average is much more than 100 barrels per kiln; while by the dry process a production of over 200 barrels per day per kiln is not unusual, and I should think an average of the production of all the dry mills would show that 175 barrels has been attained, with a coal consumption of about 110 lbs., some mills where the material is easily fused dropping as low as 90 lbs.

I was very much surprised to see a record of one week's run in a cement mill recently that showed, with five kilns in operation, a production of 256 barrels of cement per kiln for each 24 hours, with a coal consumption of 89/10 lbs. of coal to the barrel of cement produced. I think that record is greater than any I have ever heard of, and it is an absolutely correct one, as all the coal is weighed going into the kilns and all the cement coming out.

After burning the clinker, the process of manufacture differs in no way from that in use in the dry plants, the marl plants having an advantage over the dry plants from the fact that the clinker is more readily ground.

Comparing the manufacture of cement from marl and clay with the manufacture of cement from the argillaceous limestone of the Lehigh region, or from limestone and clay, the principal advantages and disadvantages are as follows:

In the manufacture from marl and clay the excavation and grinding of the raw materials are much less difficult, as the materials are all soft; but to counterbalance this you have the following disadvantages:

First, with each 100 lbs. of raw material you have to handle 100 lbs. of water.

Second, after starting manufacture the raw materials cannot be left at rest, but must be agitated.

Third, an increased fuel consumption of 50%.

Fourth, difficulty of operating in cold weather.

Fifth, reduced production per kiln.

These offset any advantages gained by the softer character of the materials.

THE WIDENING OF THE CHICAGO RIVER between Lake and Van Buren Sts. has been decided upon by the Drainage District, the purpose being to make the channel 200 ft. wide and 22 ft. deep. It is expected that the work will occupy two years and cost $2,000,000. The widening will be done on the west side, over $970,000 having already been expended in the purchase of property. The Pennsylvania R. R. has refused to accept the offer made by the District for that portion of its land which will be required, and condemnation proceedings have been ordered.

TRAFFIC THROUGH THE SAULT STE. MARIE CANALS for the year 1902 is summarized as follows by Mr. Joseph Ripley, General Superintendent, in his annual report:

Total mile-tons	29,755,916,637
Total freight carried, tons	35,961,146
Total valuation placed on freight carried	$358,306,300
Average value per ton of freight carried	$9.96
Total amount paid for freight transportation	$26,596,189.40
Average distance freight was carried, miles	827.4
Cost per mile per ton, mills	.80
Average cost per ton for freight transportation	$0.74
Total number of registered vessels using canals	935
Total number of passages by unregistered crafts carrying freight	490
Time American canal was operated, days	256
Time Canadian canal was operated, days	264
Total valuation placed on registered vessels	$70,997,400
Total number of passengers transported	59,377
Freight carried by—	
Registered vessels, tons	35,896,298
Unregistered vessels, tons	64,848
American vessels, per cent	96
Canadian vessels, per cent	4
Passengers carried by—	
American vessels, per cent	28

THE MILEAGE OF EUROPEAN RAILWAYS is given as follows by the annual report of the French Ministry of Public Works, the figures being for Jan. 1, 1902:

Country.	Kilometers.	Country.	Kilometers.
Great Britain	35,462	Norway	2,101
Austria-Hungary	37,492	Sweden	11,588
Germany	52,710	Roumania	3,171
Russia	51,400	Switzerland	3,910
France	43,657	Belgium	6,476
Netherlands	2,791	Spain	13,516
Denmark	3,067	Portugal	2,250
		Italy	15,810

AUTOMATIC DROP SHUTTERS FOR THE BETWA IRRIGATION DAM, INDIA

By Herbert M. Wilson.* M. Am. Soc. C. E.

In connection with the Betwa storage reservoir and canal works in the Northwest Provinces of India, there have been recently completed some interesting and unusual automatic drop shutters on the crest of the dam for increasing its storage capacity. As a description of these shutters and their action would be difficult of comprehension without a description of the works to which they have been added, the following brief outline of these is desirable.

This irrigation system was first proposed in 1855 with a view to building a diversion dam across the Betwa River, in order that the water from the same might be conducted through canals to the irrigable upland between the Jumna and Betwa rivers. It was found that about 1,000 "cusecs," as the British Indian abbreviates cubic feet per second, of water could be had during minimum years of rainfall. The minimum discharge of the river was estimated as 50 cusecs, while the maximum was at the time of the construction of the works believed to be 750,000 cusecs. The regulating sluices at the head of the canal at the left end of the diversion dam are calculated to admit 1,000 cusecs. This canal is calculated to furnish water to an area of 522,800 acres, of which 180,000 acres are irrigated at present. The canal works include 19 miles of main line, 163 miles of principal branches, and 380 miles of smaller distributaries. The total expenditure on the work to date, including all charges, has been over $1,500,000.

The interesting feature of this work is a masonry

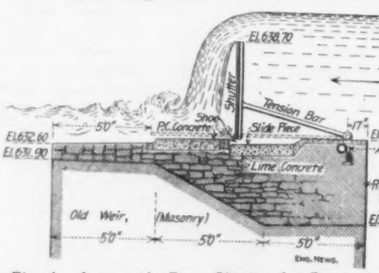

Fig. 1. Automatic Drop Shutter for Betwa Irrigation Dam, India.

diversion dam which has been skilfully located to make the most of a rocky barrier which crosses the river. It is placed on the ridge of this reef and has, therefore, an irregular plan. The height of this dam above the river bed varies from 0.4-ft. to over 60 ft., the total length between the steps on either protected abutment being 2,[illegible] ft. which was calculated to produce an affl[illegible] ex treme flood of 6.5 ft. The cross-section [illegible] this dam is unusually heavy, as it has to per[illegible] the function of a weir for a flood of great m[illegible]tude. Its top width is 15.2 ft., and its maximu[illegible]ight is 64 ft. The downstream toe of this dam is sup ported by a block of masonry 15 ft. wid[illegible]t 20 ft. high, above which the backwater of [illegible] river rises to an additional height of 10 ft., so [illegible] the flood waters fall on a water cushion of th[illegible]epth above the solid buttress. The structure [illegible]built throughout of uncoursed rubble masonry [illegible]ced with dimension stone. The available net [illegible]rag depth of the reservoir produced by this dam is 21½ ft., and its storage capacity above the canal bed is 36,800 acre-feet, though the lower 6 ft. in depth of this is of little value, as the head above is not sufficient to force it through the canal with [illegible]ecessary freedom.

In 1897 the subject of increasing the storage capacity of this dam by adding automatic drop

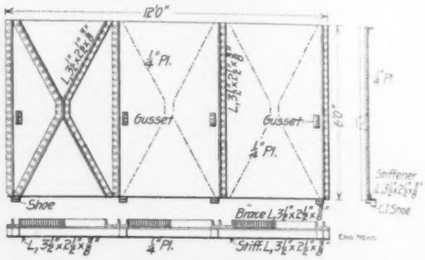

Fig. 2. Details of Automatic Drop Shutter for Betwa Dam.

shutters on its crest was considered, and the plans for carrying out this work were finally approved and carried to completion in 1901. These works consist of two parts, namely: The building up of the weir crest by the addition of 1 ft. in height of the best rubble masonry, and of shutters 6 ft. high, placed on top of these, thus making the total increase in height to which the water can be raised amount to 7 ft. By this means the gross increase in storage capacity of the reservoir with the shutters raised was 1,800 acre-feet, which is

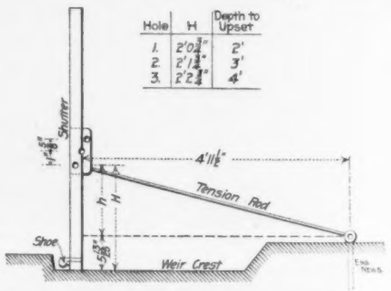

Fig. 3. Tension Rod, Automatic Drop Shutter, Betwa Dam.

equivalent to an additional nine days' full supply of the canal.

The shutters are illustrative of the latest Indian practice in the design of automatic drop gates. Moreover, they were subjected to an unusual test shortly after completion, in 1902, in the form of an extraordinary flood of 970,000 cusecs volume, instead of the greatest maximum anticipated of 750,000 cusecs. This flood passed over the crest of the dam to a maximum height of 16.4 ft., when it had been designed only to stand a previous known flood height of 6.5 ft. Fortunately the shutters worked successfully and rapidly, and neither weir nor shutters sustained any material injury. These shutters are each 6 ft. high and 12 ft. long, and as the length of the weir crest is 3,600 ft., there are 300 such shutters. They are made entirely of steel, consisting of two ¼-in. plates joined along their middle and stiffened both longitudinally and laterally by angle iron 3½ × 2½ × ⅜ ins. (Figs. 1 and 2). To the flanges of the vertical stiffeners are pivoted 1¾-in. tension bars. The other end is similarly attached to anchor bolts built 2 ft. into the masonry crest of the weir. There are four such tension bars to each

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12-ft. gate. The point of attachment of the tension bar and shutter is so designed that the gates fall automatically with a given depth of water passing over them, thus securing safety in case of excessive floods. The bottom of each gate is supplied with four steel shoes which rest upon sliding plates built into the weir rest, thus reducing the frictional resistance when the gates fall. Wooden balks, 4×4 ins., are fixed to the ends of the shutters, which have a space of 1 in. separating them, which is calked when the gates are raised.

If the 300 shutters were to fall together the shock would unduly strain the weir and the flood

Fig. 1. Map of Line Changes in Rio Grande Western R. R., in Jordan Narrows, Utah.

volume submerge the river banks below. Hence the attachment of the tension bars has been so arranged that each third gate falls under different depths of water. The first third fall with a depth over top of 2 ft., the next with 3 ft., and the last with 4 ft. Thus, after the first third fall the released water reduces the flood depth, and the latter must increase considerably to top the second, third, and so on for the last third. It was not anticipated that all the shutters would ever fall, yet this occurred in the flood already mentioned.

Careful calculations were necessary to determine the point of attachment for each group of shutters, and as a fraction of an inch would make a great difference in upsetting the gate careful experiments were made with a model gate to determine the exact point of attachment of the tension rods. So as to have uniformity of length of the latter the pivot holes in the shutters were arranged in an arc of circle at the required height from the bottom of the shoe, as illustrated in Fig. 3.

LINE CHANGES ON THE RIO GRANDE WESTERN RY. IN UTAH.

By W. P. Hardesty, C. E.*

The Denver & Rio Grande Western Ry.'s main line, extending from Grand Junction, Colorado, to Ogden, Utah, 328.4 miles, was completed in 1883. It was then a narrow-gage road, as were all the lines of the Denver & Rio Grande. It was then owned by interests closely allied to those controlling the Denver & Rio Grande. At Grand Junction close traffic connections were made with the parent road, and have also since been maintained with the Colorado Midland since its completion in 1887. (See Eng. News of Nov. 24, 1898, page 330, for notes on the Colorado roads.)

During 1889-90 the Denver & Rio Grande Western was converted into a standard-gage line, to conform to the Denver & Rio Grande, which was also standard-gaged from Pueblo to its western terminus. More lately the name of the road was shortened to "Rio Grande Western."

The greatest obstacle to operation is the ascent of the divide through the Wasatch Mountains, called Soldier Summit. Helper engines are required for a distance of 25 miles from the west to this summit; and on the easterly side they are required on the steepest part of the ascent, reaching from the foot (25 miles distant) for a distance of 12½ miles.

The maximum grade on the east side is 2.4%, while on the west side there is a continuous grade of 3.8% (compensated on curves) from the summit to Tucker station, a distance of 6.7 miles. So difficult is the operation of this section that a safety switch has always been in use (set for all trains) at a point about three miles down, and in 1897 the distance of 6.7 miles was double-tracked.

The elevation of Soldier Summit is 7,464 ft. At the foot of the ascent on the east side, 25 miles distant, is located the station of Helper, a division point for operation of trains. The road from here to Grand Junction, 177 miles, is usually called the "Desert" division.

The sections between Ogden, Salt Lake, Provo and Thistle Junction—36.9, 44.5 and 20.1 miles respectively—have more traffic to accommodate than the rest of the line, and hence have received extra attention in the way of betterments. At the latter point helper engines are used for the ascent to Soldier Summit, 25 miles further east.

Before improvements were begun between Ogden and Thistle, the maximum grade was 1.5%, and the maximum curvature 10°. In 1898 changes of line were begun, which, when completed, will result in these being reduced to 0.65% and 4° 50′ respectively, with few curves sharper than 3°.

Going south from Ogden, the first important change (which is still to be made) is at and north of Layton. The grade of the present line is to be lowered for nearly four miles, giving a uniform up-grade of 0.65% for north-bound trains. The present maximum grade over Layton hill, and at other places south to Salt Lake City, is 0.81%.

At and near the smelter town of Murray, just south of Salt Lake City, nearly 2⅝ miles of line have been changed. Grades have been reduced

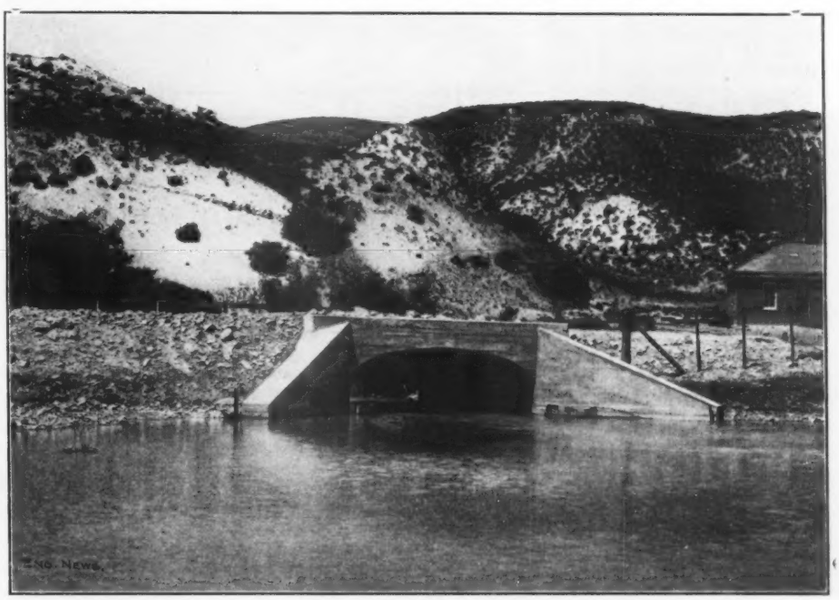

FIG. 2. VIEW OF 16-FT. ELLIPTICAL CONCRETE-STEEL ARCH OVER EAST JORDAN CANAL IN JORDAN NARROWS.
(Track Across Arch Not Yet Laid.)

to 0.5% from as steep as 1.2%. The line has been changed so that seven curves have been reduced to three, and the maximum curvature reduced from 4° 20′ to 1° 30′. Permanent structures have been put in, including one concrete culvert of 20-ft. span. The straightening of the line has eliminated several bad curves that formerly caused much danger to people crossing the railway.

About twenty miles south of Salt Lake City is the Olivers cut. This is 3,000 ft. long over all For 2,200 ft. it averages 25 to 30 ft. deep, with a maximum of 34 ft. The improvement was made in 1899, grades of 0.81 and 0.95% being reduced to 0.5%. The fills approaching the cut were raised so that the grade was changed for over one mile.

JORDAN NARROWS CHANGE.—During 1902 was made the most extensive change yet undertaken. This is about halfway between Salt Lake City and Provo, and was part of the plan of reducing the ruling gradient between those points to 0.65%. The topography here is peculiar. The Jordan River flows northward from Utah Lake with but slight fall, the bench lands on either side increasing in height until they merge with the low range of mountains that separates the counties of Utah and Salt Lake. Through this the river has cut a deep channel down to the bench lands (lower in elevation) of Salt Lake county, forming the "Jordan Narrows." This opens out into the broad Salt Lake Valley, which

*Progress Building, Salt Lake City, Utah.

is many miles wide. The "Narrows" is formed by high gravel hills or benches enclosing a flat valley ranging from 200 or 300 ft. to ½-mile in width.

To go from Salt Lake to Utah county, a railway has either to go through the "Narrows" and then climb to the higher bench lands of Utah county or else virtually to climb over the range; that is, to ascend the slope to

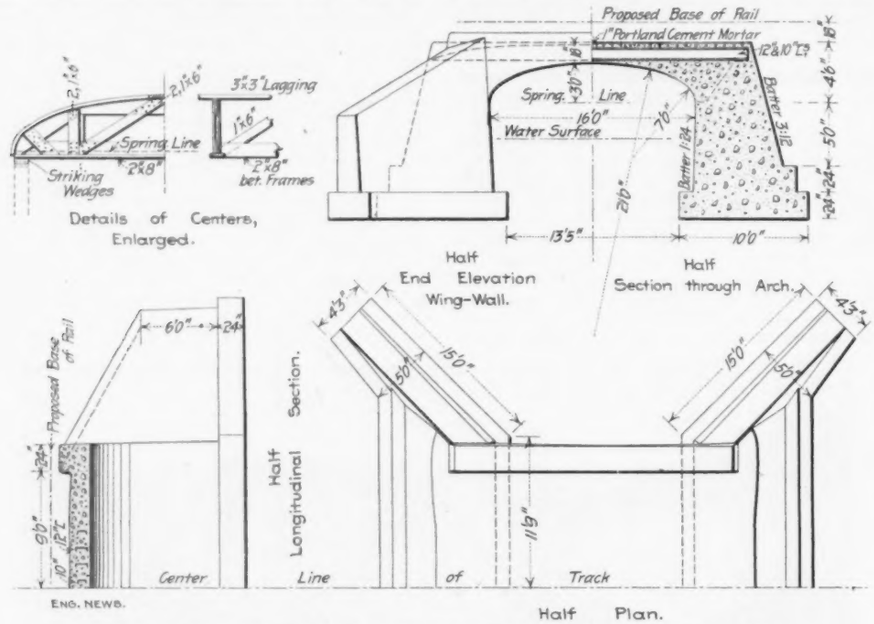

FIG. 3. WORKING DRAWINGS FOR ELLIPTICAL CONCRETE-STEEL ARCH.

one side of the gorge, passing over the gently sloping table that reaches back from the edge of the gorge, and then descend on the south side to the high benches of Utah county. The table here spoken of is one of the lower shore lines of Lake Bonneville, the ancient basin of Great Salt Lake, the surface of which is now over 1,000 ft. lower in elevation than the highest water line. The table on which the road runs, called the Provo shoreline, is about 360 ft. lower than the high water line.

This is the route taken by the main Utah branch of the Oregon Short Line railroad, and from the summit a very picturesque view is obtained of the "Narrows," over 350 ft. below. Grades of 1.5%, as well as a long detour, are required to reach the summit.

The narrow-gage road of the Rio Grande Western ran through the "Narrows" and then, with some development where the gorge opens out, gradually reached the top of the bench lands south of the "Narrows." The standard-gage line also runs through the "Narrows," but leaves the river at their upper end and climbs directly onto the bench to the south. This requires a long and heavy cut on an ascending grade, because of the abrupt termination of the bench at its north end, facing the "Narrows" at this point. This is called the "Mesa" cut. The section of road through the "Narrows," including the ascent to the bench, embraces the only really difficult country between Ogden and the mouth of Spanish Fork Canon, 94 miles.

During last season the line was straightened and the grades much reduced over this section, covering a distance of 3⅛ miles. From near the lower end of the "Narrows" to the lower end of the "Mesa" cut, a distance of 2.3 miles, the line has been changed, resulting in a great improvement, though it nowhere departs much over 150 ft. from the old line. The distance was shortened 322 ft., and the maximum curvature reduced from 6° 44′ to 4° 50′. In one place the river channel was changed to avoid two crossings by the new line.

The grade change starts at the same point as the line change, but continues for over a mile beyond where the new line joins the old one. For 17,200 ft. there is a uniform upgrade of 0.65%,

compensated on curves at the rate of 0.04 ft. per degree. The heavy grade of the old line began about one mile further up, and was almost continuous one per cent. to the summit of the "Mesa cut" bench.

The original "Mesa" cut was about 3,800 ft. long, with a maximum depth of 60 ft. at the north end, and it contained 250,000 cu. yds. The cut was lowered and extended so that it is now 5,500 ft. long, with a maximum depth of 71 ft. at the north end. The maximum lowering made in the old cut was about 22 ft., and it ran from 15 to 20

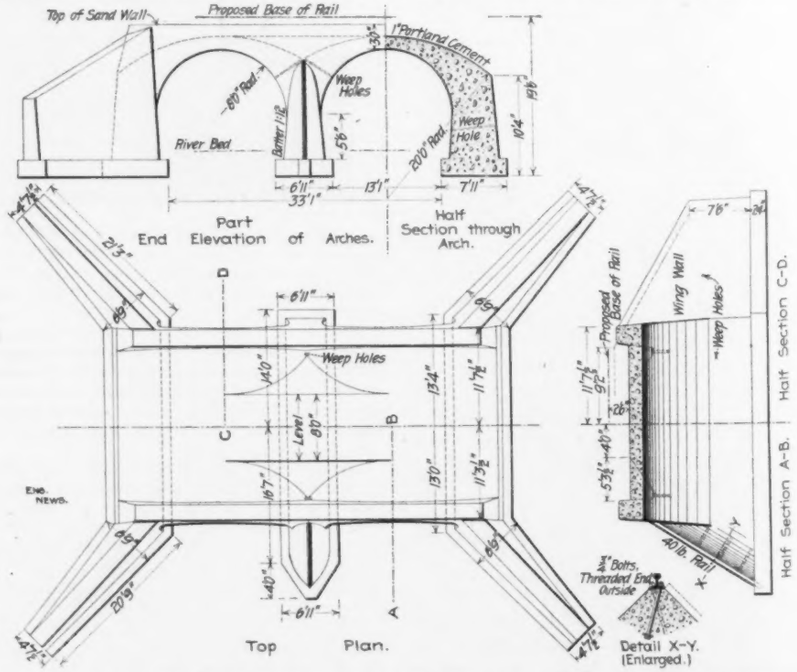

FIG. 4. DOUBLE CONCRETE SEMICIRCULAR ARCH WITH 16-FT. SPANS IN JORDAN NARROWS.

ft. for at least 4,000 ft. The summit of the ascending grade is now 2,300 ft. further south.

The material obtained from this cut is composed of gravel, sand and loam, and has been extensively used in raising the roadbed at other places along the line. On this account the cut has been widened till it averages about 75 ft. in width. It is estimated that, besides the 250,000 cu. yds. moved originally, 250,000 more were taken out up to 1902, and about 500,000 during that year, making 1,000,000 cu. yds. The original excavation was with team and scraper, but all since then has been made with a steam shovel, the material being loaded on Lidgerwood cars on one of the side-tracks. During most of the past season, a Bucyrus steam shovel, with 2½ cu. yd. dipper, has been steadily at work. Under favorable conditions, about 3,000 cu. yds. by train report (probably 2,500 cu. yds. actual measure) have been loaded per day, making about 165 carloads.

As far as possible, the embankments of the new line through the "Narrows" were put in by construction train. Each new embankment was started by team and scraper, being brought up high enough to permit of being reached by a temporary track connecting it with the operated line. It was started only wide enough to allow of a 16-foot top for the track to rest on. The embankment was then finished by construction train; 130,000 cu. yds. were put in by construction train, using material from the Mesa cut; 60,000 cu. yds. embankment were made by contractors, who also moved 60,000 cu. yds. in excavation. Included in this was one entirely new cut. This was 900 ft. long, had a maximum depth of 35 ft., and contained 30,000 cu. yds.

The hardest material encountered in the "Narrows" is a cemented gravel, which requires blasting to loosen up. It stands easily in a cut with side slopes of one-half horizontal to one vertical.

At the narrowest part of the "Narrows," across which runs the county line on the summit of the natural divide, the high ground on the east side forms a huge spur. Here the maximum curvature of 6° 44′ was reduced to 4° 50′, which is still the sharpest curve between Ogden and Thistle. To use a 3° curve here would have required a tunnel nearly 1,000 ft. long, which was not advisable, even if the formation had been such as to stand without timbering. A large amount of steam shovel work was done here in cutting further into the hill, and the work was finished by contract. The maximum side-hill cut here is 64 ft., which stands at a slope of ½ to 1.

About 20,000 cu. yds. of excavation still further south were also moved by steam shovel, the conditions being such that the material could be worked from sidings.

In pursuance of the policy to have only permanent structures, some very interesting culverts have been put in on the new line. These include two river crossings. A concrete skew arch culvert of 24-ft. spans replaces a 64-ft. Howe truss bridge

with pile trestle approaches, and one of two 16-ft. spans replaces a pile trestle 166 ft. long. Two canal crossings have pile trestles replaced by 16-ft. concrete arches, one of which is elliptical, the other being a full-centered skew arch. All the other arches are full-centered.

OTHER LINE CHANGES.—The Rio Grande Western began its reduction of grades and curves in 1898. During that year an important change was made, reaching from the south side of Springville to within one mile of Mapleton. The new line is 12,100 ft. long, about 1,000 ft. longer than the old one. This is on account of swinging it to the east (almost 1,200 ft. in one place) to secure a supported grade, which was reduced from 1.50% to 1% maximum. The sharpest curve was reduced from 4° to 2° 50′, but grade reduction was the sole object of this change.

In 1899 was made the Mapleton change. The line was changed for 3.4 miles, and the grade for 4¾ miles. The latter begins at Mapleton and extends to within the Spanish Fork canon. Two changes of the channel of Spanish Fork River were made. Maximum grades were reduced from 1.5% to 0.8%, and curves from 10° to 4°. One cut of 3,600 ft. length was required, nearly all of which is 20 to 25 ft. deep.

Besides those enumerated, many minor changes have been made in the line and grade of the road. All abrupt changes in grade have been replaced by long vertical curves, and, where possible, a long uniform grade has been used to replace several varying ones. The track in many places has been raised 3 to 10 ft. to take out sags in the grade before ballasting.

When steel bridges began to replace wooden ones, in 1898, masonry abutments were at first used, but now only concrete abutments are put in. It is the intention to use nothing sharper than 3° curves on future changes, except in the mountains. All curves of 2° and over are spiraled. The standard roadbed now adopted is 20 ft. wide for fills and 24 ft. for cuts.

For the data from which this article has been prepared, the writer is indebted to Mr. Frank E. Baxter, M. Am. Soc. C. E., division engineer of the entire line, it now being owned by the Denver & Rio Grande Ry.

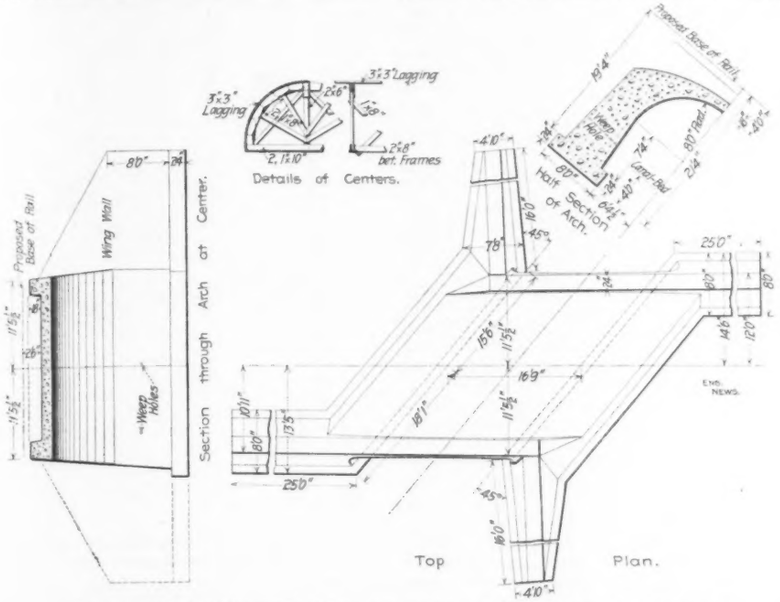

FIG. 5. SKEW CONCRETE ARCH OF 16-FT. SPAN IN JORDAN NARROWS.

THE HEISLER COMPENSATING GEAR FOR DIRECT ACTING PUMPING ENGINES.

Steam-driven pumping engines are built in two styles, direct-acting and crank-connected. Those of the former style, though light and compact compared with the others, have important defects that restrict their use to a limited range of cases, where steam economy is unimportant, etc. Chief among the defects of direct-acting pumping engines are variable length of stroke, inability to run at high speeds, unsatisfactory steam distribution, and consequent lack of efficiency. Crank-connected engines, which are provided with flywheels, overcome these defects, but only at the expense of lightness and low cost. Accordingly, we find direct-acting steam pumps used generally where a portable steam-power pump is required, while in nearly every case where saving of fuel is a consideration the crank-connected engine, in some form, is used.

Numerous attempts have been made to improve the efficiency of the direct-acting pump. In such a pump the resisting force in the water cylinder is constant throughout the stroke, and is equal to the delivery head of the pump; the steam pressure must, therefore, (neglecting the inertia effect of the moving parts), also be constant, in other words, full steam pressure must be used throughout the stroke. The advantage of steam expansion is thus entirely lost, and the machine is, as a result, highly wasteful of steam.

The inertia of the moving parts tends to correct this evil. It absorbs energy during the first part of the stroke in the acceleration of the mass of the pistons, rods, etc., while in the last part of the stroke these masses being brought to rest give up this stored energy. Therefore, instead of a constant steam pressure being required throughout the stroke, it is necessary that the pressure during the first half of the stroke be higher than average, and lower than average during the last part of the stroke. If the reciprocating parts be made very massive, this effect may become large enough to permit of quite early cut-off, resulting in a considerable degree of expansion of the steam; the pump then is comparable in economy with a crank-connected pump, in which the flywheel produces a similar equalization of pressure between the stream and the water end.

This method of compensating for variable steam pressure has rarely been employed, owing to the cost of the extra metal required and to the limitations which the arrangement imposes on speed and delivery pressure. In the D'Auria pump a column of water, contained in a closed circuit of pipe, is substituted for the heavy metal reciprocating parts; a plunger sets this water in motion during the first part of the stroke and brings it to rest toward the end of the stroke, thus equalizing the pressures in a manner similar to that explained above. A considerably more complicated arrangement for compensation has, however, been used to a large extent, following a method originally utilized by Mr. A. S. Cameron. It is used, in modified form, in the Worthington High-Duty Pump. In this pump auxiliary hydraulic cylinders are used, whose pistons are linked to the main piston rod in such a manner that they force water into an accumulator during the first part of the stroke, thereby absorbing the excess energy of the steam cylinder, while during the second half of the stroke they are driven by the pressure water stored in the accumulator, using this energy to aid the pump in completing its stroke. A somewhat similar system of compensation has been used by Mr. J. A. Groshon.*

A few years ago Mr. Chas. L. Heisler devised a direct-acting pump in which compensation is secured by novel means, without either the added weight of the first-mentioned method or the complication of auxiliary cylinders. His construction comprises essentially a link connection between the two piston rods of a duplex or a compound pump. By means of this linkage the steam cylinder of one side, during the first part of its stroke, gives aid to the other side which is then in the last part of its stroke, and in turn when near the end of its stroke it receives aid from the other side. The linkage serves one other important purpose: it gives each of the two pistons a definite, fixed length of stroke, in place of the undetermined and variable length of stroke in other direct-acting pumps. As a result of this the clearance spaces may be made much smaller, and a smooth action is obtained at all speeds.

This pumping engine was very briefly described by its inventor nearly three years ago, at the meeting of the American Society of Mechanical Engineers in May, 1900, the description being incidental to the discussion of a paper on engine tests. At that time the pump had been built only in small sizes, principally as a boiler-feeding pump, and had not yet been tried by sufficiently extended practical use. Since then, pumps of this type have been built in much larger sizes, up to a capacity of 10,000,000 gallons per day for waterworks service, and sufficient experience has been had with both large and small sizes to prove the type a practical success. On this account a description of the Heisler pump is now presented.

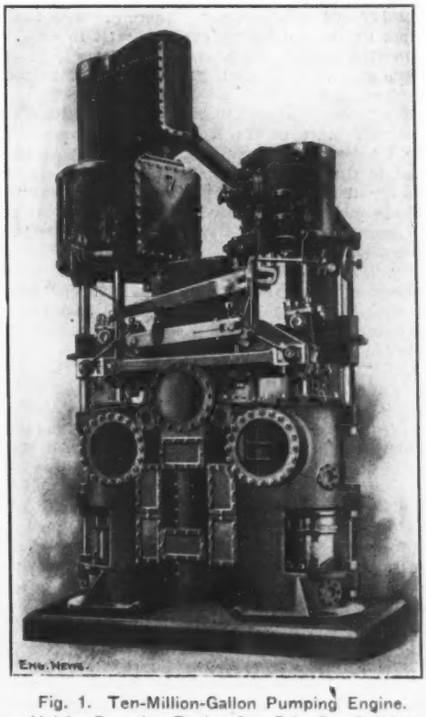

Fig. 1. Ten-Million-Gallon Pumping Engine.
Heisler Pumping Engine Co., Erie, Pa., Builder.

In Fig. 1 we reproduce a view of a large-sized Heisler pump, which illustrates well the general arrangement of the mechanism employed. The pump shown is a triple-expansion steam engine direct-connected with two water cylinders. The intermediate and low-pressure steam cylinders are set tandem, and together with one of the

*See also on this subject Eng. News, July-Dec., 1897, pp 131 and 185.

water cylinders they form one side of the pump. The dimensions of the steam cylinders are 21, 33 and 48 ins. by 24 ins. stroke, and the plungers of the pump cylinders are 19 ins. in diameter. The engine shown has a capacity of ten million gallons per day. The view brings out clearly the simple arrangement of the parts of the pump. The water cylinders, set on a bed-plate, form the supporting base of the machine, and support the

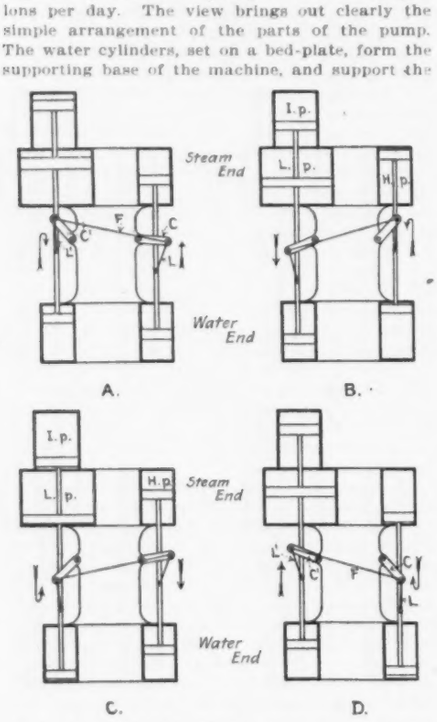

Fig. 2. Diagrams of Relative Motions of Piston Rods and Compensating Links.

entire steam end by means of a large central air-chamber and steel columns. There are no lateral forces on these columns, such as exist in crank-connected pumps; the heavily and laterally rigid frame necessary in such pumps is therefore not required.

The "compensating" linkage which is the distinctive feature of the Heisler pump is seen in Fig. 1 between the steam and water ends. As applied to the pump shown the linkage consists of two functionally separate parts: the compensating linkage and the valve gear. Since the former is the essential novelty of the pump, it will be better to explain it first.

Fig. 2, a diagram reproduced from Mr. Heisler's discussion before the American Society of Mechanical Engineers, already mentioned, illustrates the arrangement and action of the compensating linkage. The device consists of two crank arms, C and C', pivoted to the frame casting of the engine, and having their free ends connected with the piston rods by links L and L'; the free ends are also interconnected by a rod, F, which has no fixed attachment to the frame and is called the floating rod. The piston rods of the two sides of the engine being thus linked together, they have definite relative motions, and any deficiency in moving force on the one side will be made up by aid from the other side. The relative positions of the two sides at four different points of the stroke are shown in Fig. 2. At A the low-pressure side has just completed its up-stroke, and the high-pressure side has traveled about one-third of its stroke from the bottom; the former has an excess of moving force during the first part of its stroke and aids the high-pressure side during the remaining two-thirds of its stroke. At B, the high-pressure piston has completed its up-stroke under continuous aid from the other side, and during the first third of its down-stroke its excess of moving force aids the low-pressure side in completing its stroke. It will be observed that the floating rod F is in tension throughout the conditions A and B. At C and D are shown the respective positions one stroke later than A and B; evidently the action is the same as that described: the low-pressure side during two-thirds of its up-stroke aids the other side, and the latter aids the low-pressure only during one-third the stroke.

As shown in Fig. 2, the low-pressure side leads the high-pressure by about two-thirds of a stroke. With this arrangement it is clear from the preceding description that the high-pressure side receives more aid than it returns; it has the benefit of the high initial moving force on the low-pressure side during two-thirds of its stroke, while it in turn aids the low-pressure only during one-third its travel. This makes it possible to employ a very early cut-off in the high-pressure cylinder and thus secure economy in steam consumption. If the direction of motion were reversed, the above relation would also be reversed, and in this case the low-pressure side would receive more aid than it gives.

In connection with this compensating linkage Mr. Heisler usually employs a peculiar valve gear, which takes its motion from the links of the compensating motion. The purpose of the gear is to secure rapid opening and closing of the valves by an action which shall operate smoothly at all speeds. Tappets for moving the valves, as used in ordinary direct-acting pumps, are insufficient for this; they are noisy even in very small pumps and at low speeds, while with the heavier moving parts of large pumps they are out of the question. The gear devised by Mr. Heisler is rather complicated, but with the help of the diagram, Fig. 3, a little study will enable its action to be understood. In this diagram is shown a compound pump, the high-pressure cylinder being on the right, fitted with the compensating links already shown in Fig. 2. The tail of each crank arm of this linkage is extended to give an attachment for the valve-gear links. From this point of the low-pressure crank arm a lever, G, extends over to the high-pressure crank arm, in whose tail is fastened a pin on which lever G slides. This pin can be moved toward or from the crank arm center for the purpose of adjusting the point of cut-off in the low-pressure cylinder. At L L, on the lever, G, the low-pressure valve stem is fastened by means of a link. The high-pressure valve is connected in a similar way to a lever, H, which at one end is linked to point H L on the tail of the high-pressure crank arm. The other end of lever H is attached somewhat differently from lever G, being connected by means of a link to a point on the floating rod of the compensating linkage.

The action of this valve gear is, briefly, that the motion of either valve is determined in the main

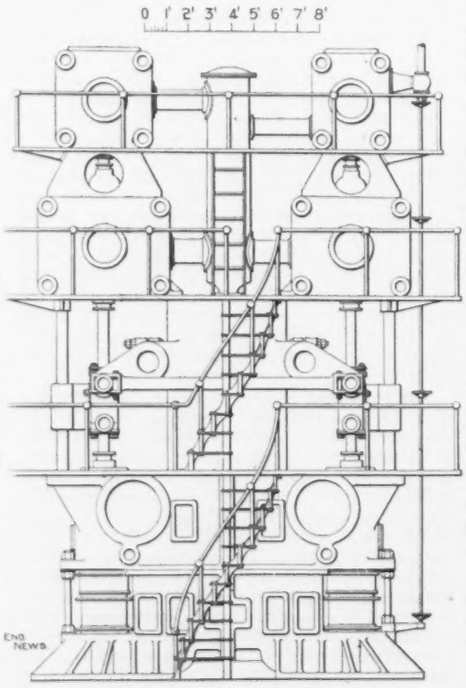

Fig. 4. Elevation of Heisler Pumping Engine of 20,000,000 Gallons Per Day Capacity.

by the motion of its piston rod, valve and piston rod moving approximately in opposition. However, when the corresponding piston is near the end of its stroke, and is consequently moving slowly, the influence of the other piston becomes the dominating one, and it acts upon the valve so as to give the valve a rapid motion in this part of its travel. Thus, when the high-pressure cylinder is near the upper end of its stroke, as in Fig.

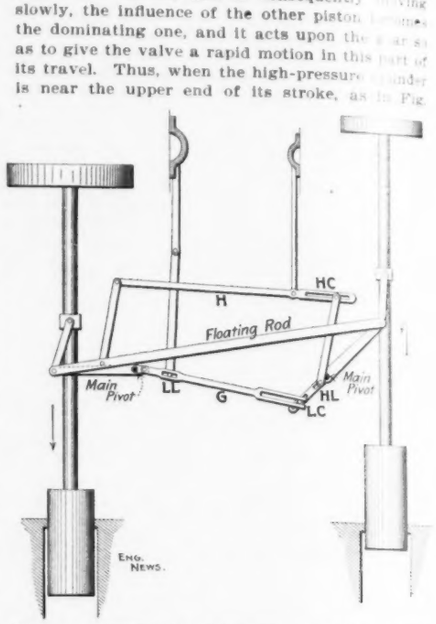

Fig. 3. Diagram of Valve-Gear of Heisler Direct-Acting Compensated Pump.

H L = High-pressure Lead Adjustment.
H C = High-pressure Cut-off Adjustment.
L L = Low-pressure Lead Adjustment.
L C = Low-pressure Cut-off Adjustment.

3, its valve is near the bottom end of its stroke, and would be moving very slowly were it not for the influence of the low-pressure side. The low-pressure piston is at this moment just beyond the middle of its stroke, and is moving rapidly. By means of the link attached to the floating rod, and the lever H, this rapid motion is transmitted to the high-pressure valve and moves it rapidly downward, opening the admission port sharply and avoiding the objectionable wire-drawing. In a similar way a sharp cut-off is produced.

At the points marked L L, L C, H L and H C, the pins connecting the separate levers of the valve gear are adjustable in the directions shown by the arrows, for the purpose of adjusting the amount of lead and the point of cut-off in the two cylinders.

The application of the Heisler compensating system to pumping engines of very large capacity is illustrated by Fig. 4, showing a design for an engine of 20,000,000 gallons per 24 hours capacity. In this case the compensating links only are used. The engine has Corliss valves, the gear for which is not shown. Evidently it must be of a type different from that described in the preceding.

A further application of this system of compensation is shown in Fig. 5, which represents a deep-well pump. The arrangement of the pump cylinders, steam cylinders, and compensating links is the same as already described except that in the present case the crank arms are turned inward, the floating rod connecting their inner ends. The action is, however, quite the same as already described. A very ingenious attachment is shown which has for its purpose to balance the weight of the long and heavy piston rods. The central point of the floating rod is linked to a piston which moves up and down in a cylinder connected with the delivery main, the delivery pressure acting against the bottom of the piston. It will be recognized that the center of gravity of the two sets of reciprocating parts moves up and down in unison with this central point of the floating rod, and lies on the same vertical. Therefore a perfect balance of the weight of these parts is obtained if the balancing piston is properly proportioned to suit the constant pressure in the delivery pipe.

It may have been observed by the reader that while there are no dead-points during the running

of the cylinders, the engine may stop in such a position that the high-pressure cylinder alone cannot start it again. For this reason it is necessary to provide a starting valve to admit high-pressure steam into the low-pressure cylinder in starting. An automatic valve of ingenious design is employed for this purpose. The valve is shown in section in Fig. 6. It is arranged in the cover of the high-pressure steam chest, and consists of a

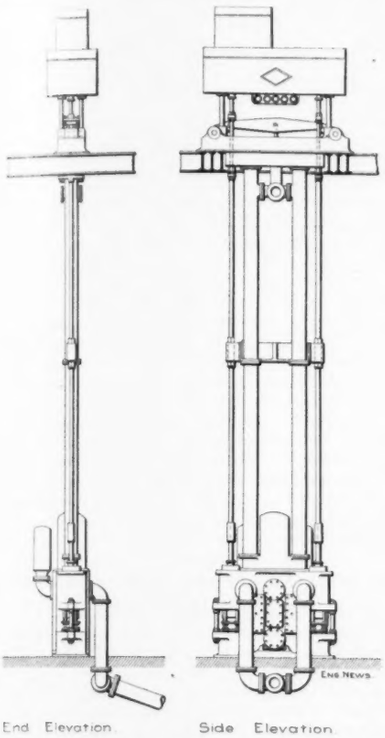

Fig. 5. Heisler Deep-Well Pump with Hydraulic Balance for Pump Rods.

compound diaphragm which separates a closed chamber into two parts. One part of the chamber is in communication with the interior of the steam chest, and the other part with the exhaust passage leading from the high-pressure to the low-pressure cylinder. When the difference between these pressures is greater than a certain amount, the diaphragm moves and opens a valve admitting high-pressure steam to the low-pressure cylinder.

As shown in Fig. 6, the diaphragm consists of two sheets of corrugated brass, 1-16-in. thick, fixed at their outer ends and held apart by separators a and b. The left-hand chamber communicates with the steam-chest by the passage c, while the right-hand chamber by means of the passage d communicates with the exhaust pipe leading from the high-pressure cylinder. It will be seen that the separator b serves as a support for the left-hand half of the diaphragm as far as the points e e, so that only the area within the circle passing through e e is effectively subject to the pressure of ths high-pressure steam. On the right-hand side, the low-pressure steam has the full area of the diaphragm to press against. Therefore, the diaphragm is in equilibrium when the pressures of the steam in the high and low-pressure cylinders are in inverse ratio to these areas. There is an opening through the center of the diaphragm, closed by a valve f. When the pressure on the left-hand side of the diaphragm exceeds the point of equilibrium, the diaphragm moves to the right and thus opens communication past the valve f through the diaphragm. In this condition the high-pressure steam can pass by way of d to the low-pressure cylinder. As soon as the pressure here becomes high enough, the diaphragm is moved back to the left, thus closing the opening of valve f,. A spring on the low-pressure side of the diaphragm helps to steady its action.

When the engine is to be started, there is no steam in the low-pressure cylinder. By opening the throttle, steam is admitted into the high-pressure steam chest, and thence goes by passage c to the left-hand chamber of the starting valve. Since there is only atmospheric pressure on the right-hand side of the diaphragm, the latter is at once forced to the right, so that steam enters the low-pressure cylinder. Steam being thus supplied to both cylinders, the engine starts, and as soon as one stroke is completed, the exhaust of steam from the high-pressure cylinder into the low-pressure renders further action of the automatic starting-valve unnecessary. A valve g is provided in the passage d, leading to the high-pressure exhaust, which valve may be closed when the automatic valve becomes leaky or deranged. The valve g is ordinarily left open, and thus the automatic valve is left free to act in case a high degree of expansion in the low-pressure cylinder reduces the pressure in that cylinder so low that the engine does not compensate entirely noiselessly. Note some remarks on this feature in the letter quoted below.

In regard to the operation of pumping engines compensated on the Heisler system, some interesting remarks are contained in a letter written us by the inventor, parts of which we quote as follows:

When the weight of the reciprocating parts is approximately balanced, as is usual, the large engine (i. e., the ten-million-gallon pump shown in Fig. 1.—Ed.) can be run at very slow speeds under all ordinary conditions. However, even now, when working at a very full load, that is, when the work done in the steam cylinders is large compared with the effect due to the unbalanced reciprocating parts, the engine can be run nicely at any speed from four revolutions (double strokes) per minute to their maximum speed.

We have put an engine in elevator service, where it is required that they stop and start repeatedly, and find we have no difficulty in doing this with the compensating device. Fortunately its fixed strokes makes it practically fool-proof, for they would have smashed the engine time and time again when the suction was plugged or when the tank from which the water was taken ran dry and the engine ran away on air. We have pumped half air and half water without water hammer, although the linkage was a little noisy when running thus. The engine maintained a vacuum of 20 ins. on the suction, which was connected up with a system of driven wells. We have knocked out the high-pressure cylinder head several times when they suddenly started up and a large quantity of water came over into the cylinder from the steam pipe; of course this would happen to any engine.

We find we have no difficulty in applying the Corliss valve gear to the compensating system. In Fig. 4 you will see the application of the system to a 20,000,000-gallon pumping engine. The outline cut, however, does not show the valve gear in place, although it gives a very good idea of the general appearance of the engine. When pumping against a constant head we balance the weights of the reciprocating parts by the use of a differential plunger (or, for deep-well pumps, as shown in Fig. 5.—Ed.). In case the head is a variable one, the deep-well balancing system is connected up either with a steam cylinder or an air reservoir as commonly used for elevator service.

We have found from repeated experiments that the successful working of the compensating mechanism does not depend upon the particular ratio of the cylinders, in fact, with any of the triple expansion engines we can compensate with the high-pressure and intermediate-pressure cylinders as a cross-compound, or cut out the intermediate and then compensate with the high pressure and low pressure, or we can use all three cylinders at the same time, and in any case, whether or not we run condensing or non-condensing, no valve setting is necessary in these changes. It is, however, necessary to properly adjust the automatic starting valve which is mounted upon high-pressure cylinder chest cover. This valve is often used as an automatic reducing valve in case it is necessary to "bleed" a small amount of steam across to bring about a more perfect adjustment; however, as a rule it is necessary to admit but very little steam across, and at times we cut this valve out entirely. When first making experiments on the smaller engines we expected a considerable reduction in economy when we admitted a very small amount of steam across from the high pressure to the intermediate, but several tests showed no appreciable difference in the economy.

As has already been intimated, pumps of the Heisler type have been found to run on a very low steam consumption. A small boiler-feeding pump, triple-expansion, with cylinders 7, 10 and 14 ins. by 10 ins. stroke, was operated under a steam pressure of 110 lbs., and at a speed of 48 double strokes per minute. The pump developed 9.17 HP. (indicated) on a steam-consumption of 235 lbs. per hour, which equals 25.6 lbs. of steam per hour for each indicated horse-power. The ordinary duplex direct-acting pump of similar size would consume anywhere from 50 to 200 lbs. of steam per horse-power per hour; under the conditions cited its steam consumption would probably be near 100 lbs., while a compound duplex would consume 60 to 75 lbs. of steam per HP.-hour. No tests have been made of large pumps of the Heisler type, but their economy would no doubt compare favorably with that of high-duty crank-connected pumps. The Heisler type of pump is controlled and built by the Heisler Pumping Engine Co., of Erie, Pa., to whom we are indebted for the information and the views and drawings from which the preceding article has been prepared.

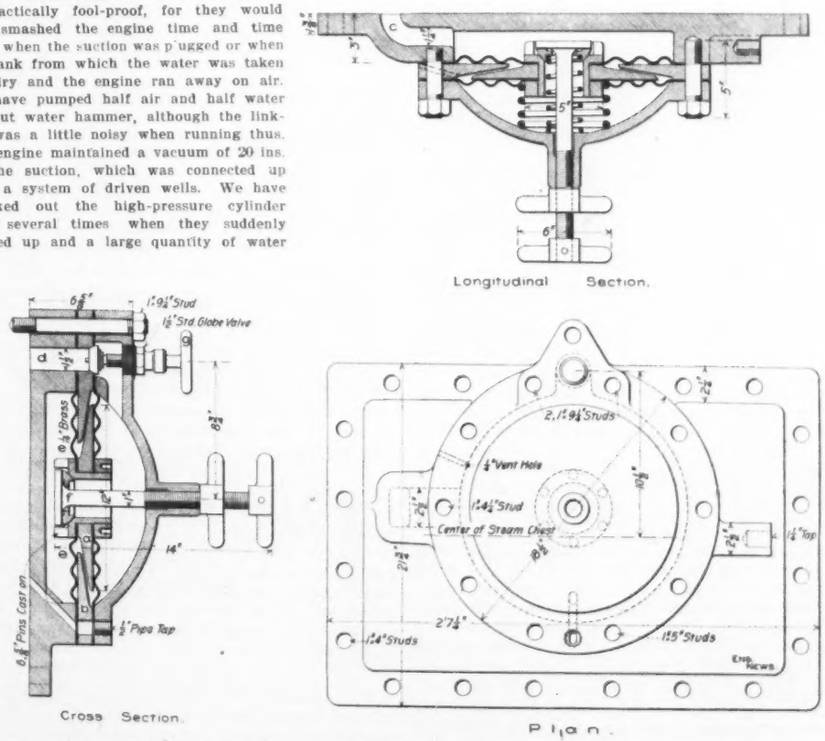

FIG. 6. AUTOMATIC STARTING VALVE ON HIGH-PRESSURE CYLINDER OF HEISLER PUMPING ENGINE.

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ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

The need of a central bureau of information to furnish engineering and scientific data is suggested by Prof. C. W. L. Filkins, of the Colorado School of Mines, in a paper published in the semi-annual "Bulletin" issued by that school. In the smaller institutions particularly, the instructors often find it exceedingly difficult to obtain information on a specific subject for use in their work.

An enormous amount of time and money is being expended nowadays in original research and investigation, and in its published record; yet the results of these investigations are often unavailable to the man who needs them for practical use. Prof. Filkins suggests the need of a central bureau to which a report on all such work should be submitted for permanent preservation and record, and, if advisable, publication, and which should supply information to those desiring it.

While the idea has many attractive features, there would be danger, it seems to us, that such an institution would be too cumbrous for practically useful operation. The great task at the present day is not to accumulate information. It is to separate the wheat from the chaff, the useful from the trivial. This is where the work done by the publishing committees of scientific and technical societies and the editors of journals in these fields is of great value. Of course, their field is limited to the matter submitted to them.

If all the results of original research carried out in all the engineering schools of this country, for example, could be submitted to a central bureau equipped with competent experts who would sift out the matter in permanent form, and relegate the rest to the oblivion whence it came, it would undoubtedly be of great benefit to the profession. The difficulty with such a scheme is that the men competent for such expert service are fully occupied with more profitable business; and unless the "sifting" is done by competent hands, its results are only misleading. An excellent illustration of this is found in the indexes to current technical literature which are being published in several quarters. It is frequently the case in some of these indexes that articles of comparatively minor importance are given a prominent place, while papers of much greater importance are either given scant mention or omitted entirely.

A very statesmanlike and dignified statement has been issued by fifteen Republican Senators of the State of New York who voted against the barge canal bill, setting forth some of the reasons which influenced them in their course and which they believe should be considered by the voters of the state in making their decision upon the matter.

The great argument brought forward in favor of the canal enterprise is that it is necessary to protect the commercial supremacy of New York city. The "Catechism" issued for the instruction of voters by the Canal Association of Greater New York says: "New York's one chance of maintaining her supremacy lies in making the best possible use of her great waterway."

This argument, we doubt not, will deceive many people to vote in favor of the canal; but its essential fallacy is well exposed by the New York Senators as follows:

> We deny that there is any condition or emergency in the development of these great commercial centers, or any lesson to be learned from their history, which would justify the levying of taxes upon the property of the State, or the incurring of a State indebtedness for an initial expenditure of $101,000,000 in this enterprise.
>
> If the welfare of the State be viewed as wholly bound up in the highest possible rate of increase in the population and wealth of these two cities, we fail to see how the projectors of the new canal can expect a growth in either much in excess of the past and present rate. The population and assessed valuation of the city of New York, treating that city as composed of the counties of Kings, New York, Queens, and Richmond, for the past eighty years are shown in the following table:

Year.	Population.	Assessed valuation of real and personal property.
1820	162,547	$79,554,196
1830	252,666	140,750,537
1840	401,612	295,700,479
1850	706,323	350,286,891
1860	1,175,674	715,034,631
1870	1,469,045	1,287,382,373
1880	1,935,359	1,425,578,487
1890	2,533,600	2,127,040,373
1900	3,437,202	3,579,809,994

> The growth in population and wealth of the county of Erie is shown in the following table:

1820	10,834	$2,208,928
1830	35,719	2,899,125
1840	62,465	13,885,512
1850	100,993	17,319,987
1860	141,971	43,077,985
1870	178,699	51,538,591
1880	219,884	119,483,203
1890	322,981	196,000,962
1900	433,686	290,934,659

> Thus in eighty years the population of our State has been readjusted so that two towns of very moderate relative importance to the rest of the State now have approximately one-half of the population and two-thirds of the wealth of the entire State. The growth of both New York City and Buffalo has been and continues relatively greater than that of Boston, Philadelphia, or Baltimore, New York's commercial rivals on the Atlantic seaboard.

The fact is that the export grain traffic, instead of being a chief factor in the growth of New York city in population and wealth, is now an exceedingly small item in the total of New York's commerce and industry. Statistics have been published, showing a falling off in the percentage of export grain shipped through the port of New York, but this falling off has caused no decline whatever in the growth of New York. On the contrary, the city has never grown at such a tremendous rate as during the past decade, when some loss in export shipments to other competing ports has occurred.

The Senators also dissect the stock argument of the canal promoters that the United States should build canals because in Europe canals are still in use and are being extended to some extent. We quote as follows:

> We are not convinced by the alleged demonstration of modern canal navigation on the Continent of Europe, whose people are burdened with enormous national debts, that the time is ripe for us to open up a new era of canal building in this State with its accompaniment of heavy State debt, but would point out that as the United States has now for many years had the greatest commercial development of any country, and New York State the greatest commercial development of any State, it would be well for us to pause before attempting to improve conditions acknowledged to be the best in the world, at a cost so heavy that it may seriously handicap our general welfare.

The Senators might have added that in Europe, where railway freight rates on the classes of goods carried by canals (bulk freights over long distances) are far in advance of the rates charged in the United States, reasons may exist for the use of canals which do not exist at all here.

The use of damp stone and sand in mixing concrete is advocated in a circular recently issued by a manufacturer of concrete-mixing machinery. We quote from it as follows:

> The old formula is to first mix the sand and cement dry, then drench it with water and mix again, then dump on the crushed stone and shovel it over once more, and the concrete is ready. If the aggregate becomes wet because of the rain, the work must stop until the sun extracts the moisture. Sand and stone always carry more or less foreign matter, as dirt, dust or loam, which should be removed to make a perfect concrete. Water applied to the sand and stone before mixing washes off and either dissolves or carries off the major part of this deleterious matter and prepares the rough surfaces of the particles to receive and retain the coat of cement. Dry cement applied to the wet surfaces of the particles adheres instantly, improves the bond, and is in its most perfect condition for mixing. Perfect mixing is accomplished when all the particles of stone and sand are coated with cement mortar, and the coarse material evenly distributed in the mixed concrete. In cement, the impalpable powder which will float on water or will rise in the atmosphere is the active agent, and the most valuable in making concrete. It forms the cohesive bond. In dry mixing, it either rises and floats in the atmosphere, or the drenching water washes it down and carries it off. Casting it on the wet aggregate, it clings and crystalizes almost immediately it comes in contact with the wet particles.

The idea is good but far from new. In hand-mixing it is probably advantageous to have the sand damp rather than dry, but the stone holds so little water that it makes practically no difference whether it be wet before mixing or not. As for stopping concrete work to wait for the sun to dry the sand and stone, it does not seem possible that any engineer can ever have committed such an absurdity.

THE ADVANTAGES OF COMPRESSED AIR OVER STEAM ON CONTRACT WORK.

We are accustomed to seeing a multitude of small steam boilers and engines on large contract jobs where derricks, concrete mixers, and drills are used. The saving in dollars and cents to be derived by the substitution of compressed air for steam on such works will be outlined in this article. To begin with there is always a large saving of coal where one large power generating plant is used in place of many smaller ones. Even well-informed contractors are not always aware of the extreme wastefulness of the small engine. Thus an 8-HP. engine and boiler on a derrick may readily consume 800 lbs. of coal per 10-hour day, or 10 lbs. of coal per HP. per hour; whereas an 80-HP. engine will require only 4 or 5 lbs. of coal per HP. per hour. Great as is the possible saving in the fuel item it by no means equals the saving in fireman's wages. One fireman can readily stoke a 100-HP. boiler, yet where the engineman is kept at all busy on derrick work, there must be a fireman for every small boiler no matter how small it is. It is not uncommon therefore to see half a dozen firemen on a job where one would serve were he employed at a central plant.

Steam can of course be generated at a central plant and piped considerable distances, with increasing loss in steam pressure as the distance increases, even in summer months. In cold weather long exposed steam pipes are entirely out of the question, hence we seldom see a central steam plant on contract work. But with compressed air there is no loss of pressure in the pipes, except the slight loss due to friction. In very cold weather there is no freezing up of the air pipes, provided the air is cooled before it begins its journey, thus removing the excess of moisture at the compressor.

The compressed air tank or receiver is not a reservoir of power as is commonly supposed. If it were it would have to be an enormous affair, whereas a small boiler-like reservoir is all that is needed. The functions of this receiver are to collect the water and grease that the air carries, and to equalize the pulsations in the air coming intermittently from the compressor. On bridge work a portable air-compressor plant mounted upon a flat car is often used to compress air for the pneumatic riveters. A gasoline engine operates the compressor, so that no fireman at all is required,

and no boiler water is needed. Very often this item of water is a very expensive one to the contractor, and here again is where the air compressor driven by a gasoline engine is decidedly economical.

Coming now to the engines and drills themselves, of course it is apparent that any engine ordinarily run by steam can be run by compressed air. The most familiar type of engine used by many contractors either with air or with steam is the power drill, and there is probably no class of engine where it pays better to use air than the power drill. The flexible marlin or wire-wound rubber hose leading from the pipe line to the drill is "rotted out" by steam in an exceedingly short time, as contractors having to make frequent renewals of this expensive hose are well aware. Compressed air, however, has no such deleterious effect. There is a further gain in the cylinder oil account, since more oil is consumed where steam is used. The fact that with air the cylinder of a power drill is always cool is of advantage also in that the drill can be more readily handled and shifted about.

We have drawn no fanciful picture of what may be done with compressed air from a central plant. One contractor, we know, has a 125-HP. boiler furnishing steam to an engine driving an air compressor which furnishes air to operate six power drills, three cableway engines, one concrete mixer engine and one derrick engine. The first cost of such a plant is actually less than the first cost of separate boilers for each of the engines enumerated, while the cost of repairs and maintenance is far less. But what is of even greater moment is the fact that the fuel item is cut in two, and the wages item of firing is one-fourth what it is when using separate steam boilers.

Compressed air lends itself also to a variety of uses not possible with steam. Thus where there is iron work going on near masonry or excavation, air may be used to run pneumatic riveters, and these same riveters provided with a cutting tool may be used to dress stone. Concrete might thus be cheaply dressed on the face, and so effect a roughened surface that would not show every slight stain or variation in color. Small pneumatic hoists, blowers on forges and many other machines about the work lend themselves to operation by compressed air more readily than by any other form of power.

LETTERS TO THE EDITOR.

Time of Transit of Typhoid Fever Germs from Chicago to St. Louis.

Sir: I was rather sorry to see in your issue of May 14 a statement that I have testified that it takes "10 days, 6 hours, and 3 minutes." for sewage from Chicago to reach the St. Louis Water-Works intake. Your source of information must have been erroneous, because I have not so testified, and would, under any condition, hesitate to state within a great number of minutes just what such time would be. Floats were observed over the whole distance, and the time taken at numerous well-known points in transit. Of course, such times were taken to the nearest minute, but the aggregate of these times does not equal the total time you mentioned. I did say in my testimony that, under conditions existing when the observations were made, the time of flow from the Chicago River to the St. Louis Water-Works Intake is noticeably less than ten and one-half days. Very truly yours,

J. L. Van Ornum.

Department of Civil Engineering, Washington University, St. Louis, Mo., May 25, 1903.

Finding Wheel Load Concentrations Graphically.

Sir: It may be worth while to point out that the graphical method of finding floor-beam concentrations under wheel-loads stated by Mr. R. H. Bulloch in Engineering News of May 21, is capable of still further simplification.

The vertical intercept through M (referring to Mr. Bulloch's figure) between e d produced and the funicular polygon is obviously (as a matter of plane geometry) m and n summed automatically and represents the concentration sought. So likewise would the vertical intercept between the funicular polygon and the line from the upper extremity of m produced through d.

Hence one straight line is all that need be drawn, in addition to the vertical through M (or N), to define the intercept which may be measured to the scale stated by Mr. Bulloch to get the desired result.

The writer finds it convenient to use three verticals drawn a panel-length apart upon a bit of tracing cloth which can be moved at will over the funicular polygon. This can be made to determine floor-beam concentrations ad libitum by marking successive pairs of points, x and y, in which the outermost of the three verticals is cut respectively by the funicular polygon and the straight line through the points of intersection with that polygon of the other two verticals. Results are then obtained by scaling the values of the successive intercepts x y.

Cutting and trying for the position of the loads to give the maximum value can be done, without actually getting all the trial values, by aid of the principles of Johnson, Bryan and Turneaure's "Modern Framed Structures," sections 92 and 99, but little or no labor is thereby saved, useful as these principles are in the more complicated problems of this nature. Very truly yours,

L. J. Johnson.

Harvard University, Cambridge, Mass, May 25, 1903.

Another Set of Hydraulic Diagrams.

Sir: I beg to call your attention to a wonderful set of hydraulic diagrams given with a paper recently published in the "Proceedings" of this Association (Vol. XIV., No. 1; Dec., 1902, and Feb., 1903). Their value is suggested by the following statement of their range of application.

From the four diagrams can be read the Kutter's formula value of the velocity of flow, the discharge (in cubic feet per second and in million gallons per twenty-four hours), for any slope, for any size of conduit, and for any of the following forms, circular, egg-shaped (either end up), or trapezoidal, flowing either full or to any depth other than full. Finally, what is even more valuable, all of the cases named may be solved for any value of "n." All of the diagrams can be read with as great precision as the data warrant. Yours very truly,

Robert L. Lund,

Secretary Engineering Association of the South.

Nashville Tenn., May 15, 1903.

(Pressure upon our space prevents the publication of the paper named, which was written by Prof. W. H. Schuerman. We have submitted the diagrams to an engineer who has much experience in construction and use of hydraulic diagrams. His comments are as follows:

(1) Diagram I is a modification of the Kutter diagram published in the back of the Hering and Trautwine translation, and though it involves less work in obtaining values of V it still requires sufficient work to be very laborious.

(2) Diagram 2 gives hydraulic radii of trapezoidal canals. This is only one factor out of many in the solution of canal hydraulics, and is only the first step in obtaining discharge data. The utility of the diagram is very limited.

(3) Diagram 3-A, 3-B, and 3-C give only the factor V, and in order to obtain the discharge it will be necessary to compute, in every case, the area and the cross-section, and then compute the discharge from the equation $Q = A\ V$.

(4) Diagram 4 is a combination of three ratio diagrams, one for circular and two for egg-shaped sections. It is very incomplete in the data which it affords.

Instead of four diagrams there are really nine.

Those who are further interested in the diagrams can doubtless secure from the secretary, at the address already given, a copy of the Proceedings in which they are printed.—Ed.)

More Concerning Specifications for Railway Construction.

Sir: There is great need to-day of a uniform specification embracing and covering everything that may ordinarily arise during the construction of a railway. Such a specification should be as brief as possible, but full enough to describe the work specifically; free from all the old-time non-enforcible nonsensical, illegal clauses, omitting all such stuff as the "sole judge," etc., for the sole judge is the Supreme Court, and all the specifications in the world will not make it otherwise. The only purpose these old clauses serve is to make the contractor look upon the engineer as a species of highwayman.

The specification should be clear, perfectly clear as to classification, and should contain at least four divisions or classes, such as earth, hard-pan, indurated clay, cemented gravel or disintegrated granite, loose rock, and solid rock. Two or three divisions will not do, for there is a material intermediate between earth and loose rock that no sane man would ask the contractor to accept as earth, and to pay him for it as loose or solid rock would be to do your employers a gross injustice. Recently one of our prominent railways attempted to pay the contractor for such material under the earth classification; he of course refused to accept the classification and carried the matter into the courts. In arriving at its decision the jury added the price of loose rock and earth, and divided the sum by two, rendering their verdict accordingly. This will always be the case. The writer had a similar case in his experience. The material was more than earth, a great deal more, yet not rock. To ask the contractor to accept the earth classification would have been foolish, and to pay him for rock would have done injustice to my employers. I do not know but what I should be ashamed of it, but I am not, for I adopted the rather unprofessional way of the jury. Howbeit, it was several years prior to the jury decision referred to. I called the contractor into conference, pointed out the case to him, told him it was my intention to pay him for one-half the material as earth and the other half as rock, as that was the only way in my power to make an equitable settlement with him. He was satisfied, he only wanted what was just between man and man, and the Chief Engineer was also satisfied. But the whole thing is wrong, no subordinate engineer should ever be placed in such an anomalous position. If he attempts to class such material as earth, he is likely to be called silly and told to correct his estimate, or if the chief should sustain him, the contractor will take the matter into court and the jury, as was recently done, will make the classification for them. On the other hand, to arrive at his classification as I did may subject him to the criticism of unthinking and inexperienced men, so there remains but one help, to use a classification that covers the ground. Four divisions may do this, not less.

Contractors as a rule (there are exceptions of course) only want what is just between man and man, and it is certainly not just to ask them to accept low grade pay for high grade material. Better by far, make a flat price of so much per yard for all material moved, regardless of classification, than to make a specification that only partially specifies. To digress a little, the engineer should, at all times, be perfectly open with the contractor concerning the work upon which he is engaged, should allow him free access to all notes, records and drawings, should furnish him full and complete copies if he desires them, making him feel that there is no concealment where his work is concerned. In this way and by letting him see that you are trying to "Do unto others as you would be done by," the courts will have but little to do as far as the adjustment of classification disputes are concerned.

Another thing we need in our specifications, is, more of them. To-day some of our leading lines send resident engineers into the field with what is supposed to be a specification, but what in reality covers "Clearing and Graduation" only, while the poor fellow may have any amount of concrete, masonry, and other work to contend with, and nothing to guide him, as to how his superior wants it done, what cement to use or anything else. It is easy to correct this; let the chief see, before the specifications leave his office that they cover every class of work that may arise, or that there is a possibility, even remote, of arising, during the progress of construction. Falling back once more on my own experience: With an instrument man, rodman and two tapemen the writer had charge of a lot of very intricate construction, all under way at the same time, and scattered over twenty-five miles. This work embraced clearing, graduation, concrete masonry, yard construction, timber trestling, steel bridging, including some perplexing overhead crossings, where all tracks were on curves, etc.

Outside of the timber trestles, he had to originate all his own plans, with nothing to guide him but a specification covering clearing, grubbing and graduation. Work was started and amongst other things it was necessary to put in a scale pit (concrete); methods and proportions were agreed upon and the pit started.

After it was well under way, the Division Engineer, a young man who had previously had no construction experience whatever, came out to view progress, and immediately decided that the concrete used was entirely too dry (it had been moderately wetted and thoroughly tamped) and ordered plenty of water, much to the contractor's delight. When the forms were removed, it was found where the watery material was used that the cement and sand had to a great extent washed out, leaving an unsightly condition, while that which had been moderately wetted and tamped had a good face. Here the man in charge (?) was to blame, as the one above him did not have the moral courage to acknowledge his error.

All this unpleasantness could have been avoided by a very few lines of specifications, instead of absorbing all the paper and ink on senseless clauses that never were and never will be operative. While this was my only case of this nature, I have seen other subordinate engineers treated with the grossest injustice, wholly and entirely for want of proper specifications covering the work in their charge; I have seen them discharged without a hearing and thus badly injured, through a blind obedience to verbal orders in lieu of specifications, while the real culprit hid himself behind that well-known cloak of confidence that permits of no defense, except in the case of union labor.

With proper specifications such acts would be impossible, just so long as the subordinate adhered to them and it was not necessary for him to receive so many verbal instructions.

You may reply, that no high-minded man would be capable of such acts, or of shielding himself in such a manner. That is true, but as Mr. Abbott says, there are shysters in all professions.

In conclusion, I would urge the Chief Engineers of the

Maintenance of Way Association to continue their good work: to get together and formulate a clear, concise specification, weeding out all useless clauses, and covering everything that may possibly arise in the ordinary course of construction. There will then be but few openings for disagreement, and it will come much nearer making "Every tub stand on its own bottom," besides accomplishing better results. Yours truly,

Arkansas, May 25, 1903. J. I. B.

"Subscriber's" Problem in Bridge Design.

Sir: My attention has been called to the problem proposed by "Subscriber" in your issue of March 19, and your comments upon it, as also to the replies and suggestions of "T. B. M.," and of Mr. Edward Godfrey, in your issue of April 16.

I would say that formulas giving the reactions for a single load placed anywhere are given in my "Mechanics of Engineering," Vol. II., which forms the twelfth edition of my "Stresses in Framed Structures." The case is simply the double pivot span, closed, and the formulas I refer to are simple and hold for any shape of frame. On page 106 will be found the formulas for all spans equal, and on page 170 general formulas for any length of spans, which are readily adapted to the present example. If "Subscriber" finds any difficulty in this respect I would be glad to hear from him by mail.

If the hinge at center is omitted, as suggested by "T. B. M," the case becomes a continuous framed girder of three spans, and the reactions for a load anywhere are given for any shape of frame by the general formulas on page 174.

I hardly need to say that the method of solution consists in tabulating the stresses for each load in each member, as fully illustrated on page 162. The maximum stresses are thus easily found. The method is necessarily long and tedious as regards numerical computation, but it consists only of repetitions of simple operations, which can readily be systematized for office work, so that two computers can check step by step.

Any sectional areas desired may be assumed for any members, as suggested by Mr. Godfrey. I would assume for a first trial, all members of equal area. In such case all areas cancel out and the formulas are simplified and the labor of computation much reduced. After finding the reactions and corresponding maximum stresses under this assumption of equal areas the members can be proportioned for these stresses so as to have a constant unit stress. A second calculation made with these areas can then be made, but I venture to say that such a repetition will not be found necessary. Certainly not more than once.

This method it should be noted, is very different from starting with a "guess based on theoretical stresses and areas," in the sense used by Mr. Godfrey. It is an orderly method of successive approximation, and is free from all the objections to which he alludes.

A. J. DuBois.

New Haven, Conn., May 11, 1903.

Calculation of Two-Hinged Arch with Cantilever Shore Arms.

Sir: In Engineering News of April 16, I suggested a two-hinged arch with cantilever shore arms in place of a three-hinged arch with continuous shore arms. In connection with this you asked for a method of obtaining the influence lines for calculating the arch. The following gives a method for this work:

It is evident in the proposed bridge that the horizontal thrust H is of importance only in the members of the main span, and that the stresses in the members of the other spans can be easily determined as for an ordinary cantilever.

To determine the stresses in the different members of the main span I would suggest the following and generally used method, which is based on the assumption that the web-members are of no importance for the deflections. As the sections of the chord-members have to be known to be able to make any accurate calculation of the deflections, a practical method would in this case be to choose a mean section F_o for the members of the top chord and another mean section F_u for the bottom chord.

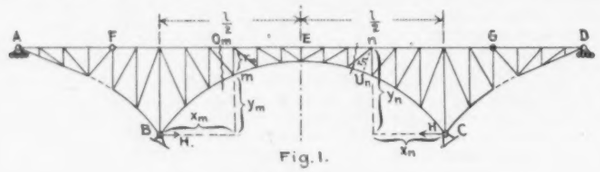


Fig. 1.

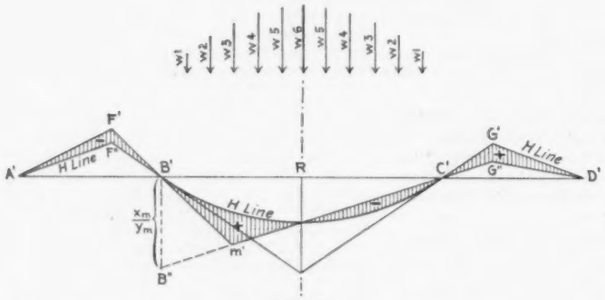


Fig. 2.
Influence Line for Top Chord Member O_m.

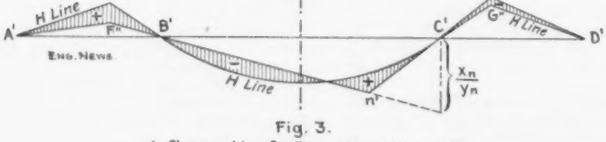


Fig. 3.
Influence Line for Bottom Chord Member U_n.

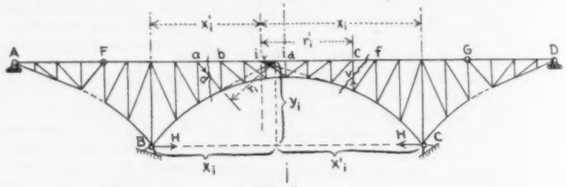


Fig. 4.

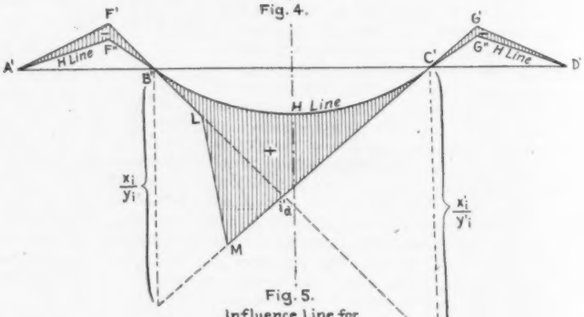


Fig. 5.
Influence Line for Diagonal Member d.

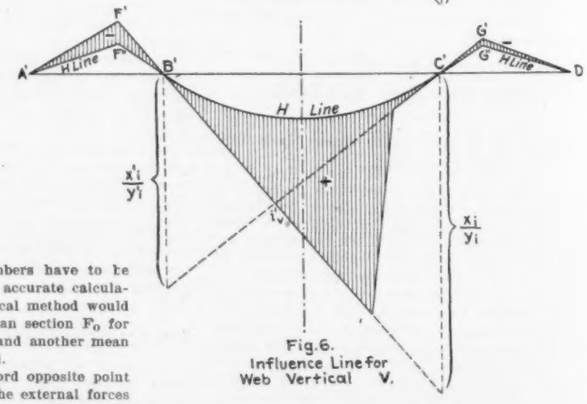


Fig. 6.
Influence Line for Web Vertical V.

CALCULATION OF TWO-HINGED ARCH WITH CANTILEVER SHORE ARMS.

The stress O_m in the top chord opposite point m is equal to the moment of the external forces about that point divided by r_m, the vertical distance from m to O_m:

$$O_m = -\frac{M_m}{r_m}.$$

O_m can be found by drawing the influence line for M_m.

$M_m = M_{om} - H y_m$; (see Fig. 1) in which equation M_{om} is the statical moment of the external forces to the left of m and in regard to point m, under the condition $H = O$,

$$M_m = y_m \left[\frac{M_{om}}{y_m} - H\right].$$

Following this formula, draw the influence line for H by calculating the fraction

$$w = \frac{s_m \cdot y_m}{r^2_m}$$

for all panel points in top and bottom chord, multiplying them by 1 ton, and drawing the force polygon with a pole distance $w_h = \Sigma\, y \cdot w$. In this s_m equals the length of panel opposite m, and y_m the ordinate of m. The string polygon thus obtained is the influence line for H.

The influence line for $\frac{M_{om}}{y_m}$ is obtained by laying off $\frac{x_m}{y_m}$ multiplied by 1 ton, from B' to B'' and completing diagram as shown in Fig. 2, x_m being the abscissa of m.

The shaded surface in Fig. 2, when multiplied by the multiplier $u = y_m$, represents the influence area of M_m. Bearing in mind

$$O_m = -\frac{M_m}{r_m},$$

Fig. 2 represents the influence line for O_m.

Draw in the same way as for O_m the influence line for U_n, since

$$U_n = +\frac{M_n}{r_n},$$

r_n being the vertical distance from n to U_n (see Fig. 1).

The shaded surface in Fig. 3 represents the influence area of M_n, the multiplier being $u = y_n$, since the original formula is

$$M_n = y_n \left[\frac{M_{om}}{y_n} - H\right].$$

In order to draw the influence line for a web-member, as d, see Fig. 4. The moment around point i_d is $M_i = d \cdot r_i$, where r_i equals the perpendicular distance from i_d to d.

$M_i = M_{oi} - H \cdot y_i$; M_{oi} being the statical moment of the external forces on left side of the section through d, under the condition $H = O$, and y_i being the ordinate of point i_d. Then,

$$M_i = y_i \left[\frac{M_{oi}}{y_i} - H\right],$$

and

$$d = \frac{y_i}{r_i}\left[\frac{M_{oi}}{y_i} - H\right].$$

Following this formula draw the influence line for d as shown in Fig. 5. The shaded surface is the influence area of d, the multiplier is $u = \frac{y_i}{r_i}$. Note that the influence line between a and b must be a straight line, therefore draw L M.

Draw the influence line for any vertical member, V, similar to that of D, see Fig. 6. The shaded surface is the influence area of V and the multiplier is $u = \frac{y_i}{r_i}$, r_i being the vertical distance from i_v to V.

After finding by the foregoing method the different influence lines for all members of the main span, obtaining

the maximum stresses of them and designing the different sections, a refiguring has to be done, since the mean sections of the chords, F_o and F_u, have till now not been taken into consideration.

The more exact method is to calculate the values of w for the top chord separate from those of the bottom chords. If F_m is the section of the top chord opposite m, and F_c is any assumed constant section; then

$$w_m = \frac{s_m \cdot y_m}{r^2_m} \cdot \frac{F_c}{F_m} \text{ (top chord).}$$

Since F_o is the assumed constant section for all members of the top chord, and F_u the assumed constant section for all members of the bottom chord, by making $F_c = F_o$ the fraction $\frac{F_c}{F_m}$ becomes equal to unity. Then for the top chord,

$$w_m = \frac{s_m \cdot y_m}{r^2_m}, \qquad (1)$$

and for the members in the bottom chord $\left[\frac{F_c}{F_n} = \frac{F_o}{F_u}\right]$,

$$w_n = \frac{s_n \cdot y_n}{r^2_n} \cdot \frac{F_o}{F_u}. \qquad (2)$$

Draw first the string polygon for all values of w_m (Eq. 1), then draw the same for all w_n (Eq. 2) and repeat this for different ratios between F_o and F_u, until the right ratio is obtained in order to get a suitable stress S in the different members. The influence line for H will be the sum of the two string polygons.

Note that as the sections near the center of the span have a special influence on H, the ratio of $\frac{F_o}{F_u}$ ought to be taken directly from these members and because they are very nearly level ought for the first calculation to be chosen equal to 1, as done by the method already explained.

The influence of temperature causes a horizontal thrust H_t, found from

$$H_t = \frac{e \cdot t \cdot l \cdot E \cdot F_o}{\Sigma\, y_m \cdot w_m + \frac{F_o}{F_u} \cdot \Sigma\, y_n \cdot w_n},$$

where

e = .00012;
t = temperature in degrees C.;
l = length of span in meters;
E = 2,200;
F_o = section of top chord in sq. cm.;
F_u = section of bottom chord in sq. cm.

After calculating H_t, draw a force polygon and add all these stresses to those already found, disregarding the signs.

As to the misunderstanding of the sliding joint, mentioned in a foregoing number of Engineering News, I thought the idea was to simplify the calculation of the construction by getting rid of the statically indeterminate thrusts. This is partially attained by getting rid of H. A statical determinate construction would be obtained by making a sliding spring joint, which could not transfer the vertical loads. This would be as I before have mentioned a single cantilever construction, but not to be preferred. Yours truly, T. B. M.

Pittsburg, Pa., April 24, 1903.

(The method suggested by our correspondent is one proposed, we believe, by Müller-Breslau. It consists in neglecting the deflections due to web-stresses and assuming a constant cross-section for the top chord and another for the bottom chord. If the latter be taken equal to each other, the equation for H, the arch thrust, is rid of all factors involving the cross-section area of the arch members, so that the influence lines and therefrom the stresses, can be found directly. Müller-Breslau recommended this for preliminary design, from which the stresses could then be calculated by more exact methods and the sections corrected. In view of the several assumptions involved in the approximate method, it might be desirable to make the second or corrective part of the calculation by the rigid method of deflections, instead of merely introducing the ratios $\frac{F_c}{F_m}$ and $\frac{F_c}{F_n}$. It does not seem that in an important design it is justifiable to neglect the influence of the web-members.—Ed.)

Another Vote for the Union Engineering Building.

Sir: At a meeting of the Municipal Engineers of the City of New York, held in the rooms of the American Society of Mechanical Engineers on May 27, the following preamble and resolutions, presented by a committee consisting of Messrs. O. F. Nichols, Chairman, Henry R. Asserson and Samuel C. Thompson, were enthusiastically adopted:

WHEREAS, Mr. Andrew Carnegie has, in a letter addressed to the four national engineering societies and the Engineers' Club, generously offered to give the sum of about one million dollars ($1,000,000) for the construction of a building to be devoted to the general interests of American engineering; and,

WHEREAS, The spirit and dimensions of the gift indicate the intention of the liberal donor that the building should be used in the broadest and fullest extent by American engineers; therefore,

RESOLVED, That this society desires to express its profound appreciation of the broad interest taken by Mr. Carnegie in American engineering and the generous gift by which he has characterized this interest and,

RESOLVED, That this Society of Municipal Engineers of the City of New York hereby expresses its earnest hope that the five organizations to which Mr. Carnegie addressed his offer will unanimously accept the magnificent gift and work in the fullest harmony to carry out the trusts imposed upon them by the donor for the advancement of American engineering.

It is proposed to send a copy of these resolutions to Mr. Carnegie and to each of the five organizations mentioned.

Very respectfully,
Wisner Martin, Secretary.

P. O. Box 256, New York City, May 28, 1903.

Concerning the Engineers' House.

Sir: You have suggested that perhaps some members of the American Society of Civil Engineers might be interested in my opinion on the grand project for a union building for the four great national engineering societies. That opinion is quite clear and definite and has been for some years; but until Mr. Carnegie made his generous and public-spirited offer there seemed to be no practicable way of realizing a hope which has long been cherished by many of the wisest and most devoted members of the societies.

For housing the four societies in one building, there are a number of reasons more or less important, and there are some reasons against it. There is one great reason for it, vastly more important than all the rest, so important that all the other reasons for and against may be left out of sight entirely. This is the effect of such a step in advancing the unity, the dignity and the power of the engineering profession.

It is proposed to erect in the heart of the city of New York a commodious and stately engineering building. That building will overlook a beautiful park, and also the new united library building, which we hope will be for some centuries one of the noble architectural features of the city. It will be within a few steps of half a dozen of the best clubs of New York—the Union League, the Century and the Republican Club amongst them. The Engineers' Club will be under the same roof. The new house will be within five minutes' walk of the Grand Central Station and of an important station of the Interborough Rapid Transit and within three minutes' walk of a station of the Sixth Ave. elevated. It will be within eight minutes' walk of the Manhattan Station of the Pennsylvania Railroad. So far as we can see, therefore, the convenience of the site and the dignity of the region are fixed for all time.

The effect upon the public mind of a great engineering house so situated will be to increase the prestige of the profession. The sagacious men who for centuries have directed the affairs of the Roman Catholic Church have seldom failed to recognize this useful principle in the choice of sites for their buildings.

But the effect upon the engineers themselves will be far more valuable. It will increase their pride and interest in the profession, and the convenience and attractiveness of the house will increase the attendance at the gatherings, formal and informal. All of this is important, but the most important result will be the development of the idea of the actual unity of the various branches of the engineering profession. We all talk much of the specializing of the age, but it is probably safe to say that never in the history of the profession has a comprehensive grasp of the fundamentals of the various specialties been so necessary to eminence, or even to large success. The civil engineer can no longer sit apart from the mechanical engineer and the electrical engineer. If he is going to organize and direct the affairs of the modern world, he must be able to command intelligently all the varied resources of his art. That command he can only get by constant and sympathetic intercourse with practitioners in all the specialties; he cannot get it at college or in his library and office.

I shall not dwell upon the value of a union library; or the desirability of a large audience room for general meetings and of small rooms in which folks can hear each other; or upon the convenient opportunities for meeting individual members of the societies which a union house will offer. Others have discussed these points, and others will. I wish here only to make prominent one idea: the working unity of the profession.

One of the greatest royal families of history went to decay because it ceased to learn and could not forget. I have no fear that the Bourbons in the American Society of Civil Engineers are a large percentage of that vigorous and noble body.

H. G. Prout.

Swissvale, Pa., June 1, 1903.

The Engineering Building of America, and the American Society of Civil Engineers.

Sir: In response to your courteous invitation, it affords me pleasure to make the following brief observations relative to several recent utterances which have appeared in the "Engineering Record" and in Engineering News, anent the subject of the Engineering Building. Please note that I omit from the title the word "Union," as, in common with the view editorially expressed by "The Engineering and Mining Journal," I regard the term as inexact, somewhat misleading and being too close a reminder of mal-odorous "unions," which stand for retrograde rather than progressive action. Therefore, let us draft the title like a generic patent claim, in the broadest words possible, inclusive of all future amendments or modifications, THE ENGINEERING BUILDING OF AMERICA.

Lack of knowledge of the written law does not stand as an answer to its violation; and the engineer whose work fails as the consequence of using incorrect data, usually is, and deserves to be, as fully censured as if he were without knowledge of the principles under which the data were made use of. And the same applies to a publication which purports to dispose of reliable information, for a consideration, to its readers. Let us see what this preamble logically leads to:

On page 511 of the "Engineering Record" of May 16, appears this: "The Society (that is the American Society of Civil Engineers) will find a means of *being represented, unofficially*, at the conference and of *assisting* its sister societies towards the realization of their aspirations for a home." [The italics are mine.]

Just how a society is to be at one and the same time "represented" at a conference, and yet this representation is to be "unofficial" does not appear; but there is no ambiguity in the pretentious paternalism of this editorial utterance that, "unofficially" the Society may condescend to charitably *assist*.

Permit me to say, as a matter of direct personal knowledge, that if the American Society of Civil Engineers does not desire (and its reasons need not be given) to become a party to this move of progress, it has merely to say so and the three remaining National societies and the Engineers' Club are free to go on without further delay and without the necessity of further conference with Mr. Carnegie.

In the same editorial it is stated: "It is, of course, a fact that the Society's one-fifth share in the proposed building will not be worth so much in cash as its present building, and will certainly not be so commodious."

The first of these statements is incorrect and absurd. The Society's addition to its present net assets would be at least, from $200,000 to $250,000. The net cost of the land and house now occupied by the Society, as set forth in Major Knap's last statement as treasurer, is approximately $196,000, and the then unpaid balance of the mortgage was $65,000 with about $26,000 cash; or say, net live assets, according to this statement, of $157,000.

But land values have advanced, even in our ill-chosen location, and it may be conservatively expected that the present property can be disposed of for, say $275,000 (if more, so much to the good), whereby the net available assets of the Society would be about $236,000. Therefore, as the Society may, if it elects to come in, have a land equity to the value of say, from $125,000 to $150,000; a house to the value of, say, $200,000 to $250,000, and a cash surplus (available for immediate useful work) of, say, $125,000 to $150,000, the absurdity of the assertion quoted is evident. Such a statement is tantamount to saying that $100 added to $100 does not result in a sum larger than either.

As to the matter of commodiousness; if this is to be measured by the space occupied by the members who *now* daily visit the Society House, and who would be likely to visit such a Temple to Engineering as will be erected in the center of the city's activity, then this is correct. In my opinion, however, there will be vastly less *desolation* in the new house and *more business* for the Society's employees, all for the good of the members at home and afield.

Referring now, to the two lengthy communications of Mr. J. J. R. Croes, a Past-President of the Society, which appeared in the "Record" of May 16, and in Engineering News of May 28, I beg to say: first, that I have offered to acquaint Mr. Croes with such facts, in their proper sequence, as would, in my opinion and that of others, have made it quite obligatory upon him to considerably amend, if not apologize for, many of the statements and deductions which he has made in opposition to favorable action by the Society on this project; but as this offer was not availed of, I feel justified in assuming that he desires to stand on the presentation which he has chosen to make.

Mr. Croes' first serious objection seems to be, in a word, that a full-fledged official committee did not, like the autochthon, rise fully made, matured and duly articled instead of presuming to follow the process out of which came the grand old Society itself! He, moreover, presumes to do some thinking for Mr. Carnegie as to whether or not he had properly considered "the feelings existing," etc., etc. Possibly, I may also be permitted to assume a

thought for Mr. Carnegie, namely: That inasmuch as he had long been on the Society's list of "Subscribers," *and was a liberal donor toward its present habitation*, it might not be above us to favorably consider the acceptance of more in the same direction! Especially might Mr. Carnegie have so mused as everyone he had so far come in contact with (as he had not then learned of their being "irresponsible promoters") regarded the project as a magnificent one for *Engineering*; and that this view of the matter was somewhat bigger and better than the consideration of the rules of the "Civil Service Examination" under which a candidate to membership in any one society is elected.

But Mr. Croes might have been forgiven even for all this, and have confined the debate to the broader text of conservatism *versus* repression, had he not, with evident care, and possibly with quasi-official assistance, drawn the following, in which the italics are mine:

All honor to Mr. Carnegie for his noble and generous offer, but the manner in which it has been brought about and in which it is attempted *to force its acceptance as framed*, constitutes one of the *most audacious and impertinent attempts by irresponsible outsiders* to overthrow and reverse the well established policy and purpose of a prosperous and well organized institution, that was ever heard of.

Who were these "irresponsible outsiders?" Well, at the first, the very first, meeting which was brought about *as the result of the suggestion of Mr. Carnegie* (whom even Mr. Croes promulgates in express terms as one who "was prompted by generous impulses"), there were present, one afternoon at the Engineers' Club, the President and the Secretary of the American Society of Civil Engineers; a Past-President of the Mining Engineers; the Treasurer and the Secretary of the Mechanical Engineers; the President and a Director of the Electrical Engineers; the President and the Chairman of the House Committee of the Engineers' Club, and, by courtesy of these gentlemen, a Past-President of the Club, who was also an ex-Treasurer of the American Society of Civil Engineers; and, finally, an Honorary Member of the American Society of Civil Engineers, whom I, in honor to us all, must name, Mr. John Fritz.

Now, I state with certainty, and due consideration of the words used, as one of those then present, that the concensus of the opinions expressed was favorable to the project as a whole; and favorable to the method proposed for carrying it out. And among these eleven "irresponsible outsiders" present at that conference, *five* were members of the American Society of Civil Engineers; in fact we might say six out of twelve; as the then President of the Mining Engineers, who is a member of the American Society of Civil Engineers, could not attend, but was in full accord.

The next step in this "most audacious and impertinent attempt" was the appointment, by these irresponsibles, of a committee to wait upon Mr. Carnegie in response to *his* original suggestion. This committee I will mention by name: Mr. Fritz, Mr. Kafer, Mr. Scott, Mr. Rice, Mr. Thomson (the undersigned), and Mr. Redding, the "counsel to the promoters." The result of that meeting was the unparalleled, magnificent, splendid, unfettered, free and in every way lovely and manly action of Mr. Carnegie; which for the first time, and the only time, has made it financially possible not to merge, nor to unionize, nor to combine, but to conveniently and agreeably GROUP the National Engineering Societies of America.

That the Engineers' Club was brought into it was at Mr. Carnegie's suggestion; and in this respect, at least, he would seem to have some right in that he for years has been a member of that club.

Moreover, at that meeting the contingency was brought up that the Am. Soc. C. E., having a little house of its own, and known to have a few members who could be depended upon to incline backwards to any project not proposed by themselves, or words to that effect, it, therefore, might not deem it expedient to come in. I might here say if this were personally addressed to Mr. Croes and others of his contention, that by such generous assistance (that is to remain out) the shares of the other societies would be increased. The understanding was forthwith reached, that in event of the "Civils" remaining out, the million dollars and the financing of the land would be available to the others! Moreover, Mr. Carnegie, after the discussion of this phase of the matter, himself brought up and assured us that in event of the project failing, for any cause, there would be no obligation for the money to be advanced for optioning the land, that is, up to $100,000. In the light of the above related facts the incorrect assertions above quoted about "forcing acceptance" and "assisting" sister societies can well be understood as not going down very pleasantly.

In this connection it seems worth while to quote one additional remark of Mr. Croes, wherein he refers to the Engineers' Club of New York, a social organization of 1,000 members and with a lengthy waiting list (in which club we even take Presidents of the Society!), as one which "is chiefly known as a convenient meeting place for engineers, contractors and sales-agents." As Mr. Croes is not a member of the club he doubtless elects to thus deliver himself under a *guest's* privileges; hence I am precluded from a discussion of his estimation of the club's function and membership, to which I also have the honor to belong.

I cannot for a moment believe that such of the narrow gage views as have so far appeared in respect to this matter are representative of the opinions of the majority of the members of the Am. Soc. C. E. Such members as I have come in contact with, and I have conversed with many, have considered the project with favor, broadly, and have not hesitated to decry the penny-a-line policy which would hang up, or prevent, the hearty and prompt acceptance and co-operation of the Society until, say, the width of the front door and the location of the mailing clerk's desk shall have been decided upon. The remark, as to this general line of procedure, has been made that it is not good engineering. Well, in my opinion, it *is* good engineering; the reverse may rather be said to be in the nature of good draftsmanship. The question now is whether the engineer or the draftsman shall come first.

There are, in my judgment, at least three controlling reasons why the American Society of Civil Engineers should come into this grouping of the societies:

First: Because of location. The present location is inconvenient, very much so; both to resident and non-resident members. It is betwixt wind-and-water, and has but recently become a front outlook to Mr. Gould's stable. It is out of the hotel center, the theatre center, the club center and the railroad centers of New York. This is not a good selling argument; but it is a statement of fact and cannot be successfully controverted. I make this statement as in the nature of a confession of error of judgment; for I was the chairman of the first building committee and strongly opposed the 43d and 44th St. location, urged by my fellow members of the committee, Col. Prout and Mr. Crowell, and also by Mr. Morison, then President of the society. The 57th St. location won.

In my opinion, the daily attendance of members would be immediately doubled or trebled and the attendance at the regular monthly meetings increased easily 50% by the accretion of members who now absent themselves because of the inaccessibility and the loneliness of the present location. I regard this as a matter of such importance to the Society that I believe it well worth the while to consider a change of location even if it should not conclude to become one of the group.

Second: The second reason why the Society should decide favorably is that it has more to lose if it does not come in and more to gain if it does come in than any of the others. It has more to lose, if it does not come in, because of its present prominence; it has more to gain, if it does come in, because of its excellent financial condition, which will permit it to immediately add greatly to its library; to take up work of original investigation; to undertake researches and investigations on special subjects; and, moreover, with such an income as it would then have, it can afford to pay such a salary to an Executive Secretary as will command the highest character, technical talent and rhetorical ability available.

Third: The contact with other organizations cannot fail to be of the greatest benefit—to broaden, to elevate and to energize the Society itself. And if it would be thus benefited—it could not fail to be—the splendid context is that in accordance with all such human actions, there must be an equal and opposite reaction, to the benefit of all.

In this connection I shall take the liberty of quoting a brief extract from a recent personal letter received by me from Mr. Geo. S. Morison, Past-President of the Society:

My impression is that when this is arranged [referring to the consummation of the project] the fund will be considerably larger than you named; and will be large enough to form an endowment which will enable us to improve our publications, to increase our prizes and, in various ways, *to step forward in the world*. [The italics are mine.]

That is the slogan: "*to step forward in the world!*" And with it I would merge another, contained in the following eloquent and earnest words of that Captain of Engineers, he the *doer of things* which have been so potent in making the present condition possible, the charitable, the broad-minded, the venerable and yet ever-young—Our John Fritz, whom Mr. Carnegie thus designated in the Fritz Medal Album: "Nestor of Iron and Steel Mechanics in America!"

But no one society of engineers can claim that its members did it all; for it has all been accomplished by their united efforts. I most ardently hope they may still become more closely associated, both on social and on engineering lines. The societies are so interdependent, and overlap each other to such an extent, that to me it is most surprisingly strange that the efforts which have been made before this time to bring them in closer contact with each other, have not been successful."

. . . . . .

Finally, it is the young men who will derive the greatest advantage by the adoption of the proposed plan. Should this plan fail, and were I a young man, knowing what I now do on the subject, it would be one of the objects of my life to devise some means by which the *younger members of our profession could be brought into closer unity.*

That is, let us not look to the past, which can accomplish no more, but to the future from which newer and better things ought to be developed; and will be if the spirit of progress is not over-cast with "the mists of prejudice."

In the foregoing I have not attempted to "write." I have simply, as it were, talked freely and openly as the thoughts have come to my mind during many interruptions; and, concluding, have but to add that the [illegible] work, such as it is, and the longest and closest [illegible] which I have performed in the line of society duty, has been done for the American Society of Civil Engineers. I take second place to none in my regard for this, my Alma Mater of the technical societies. But we are in a growing time; and science grows with it. Much can be done, doubtless, by segregation; but vastly more by conscious aggregation. Let us "*step forward in the world*," and "*wind ourselves lovingly around the truth.*"

Very respectfully,

John Thomson, M. Am. Soc. C. E.

253 Broadway, New York City, June 1, 1903.

A Small Dam at Roxbury, Vt., and Its Failure.

Sir: Engineering News of April 9, 1903, mentioned the failure of a small dam at Roxbury, Vt. Having watched the construction of this dam with all the interest of a boy in his teens, being deeply impressed with the magnitude of the undertaking, and hearing the wise discussions of its high quality, and its great strength, by the men of the town, I have always remembered it, and will contribute a short description of the structure.

The railroad station at Roxbury is within 100 ft. of the summit of the Central Vermont line, between White River Junction and St. Albans, and the elevation of this summit is very close to 1,000 ft. above sea level.

The brook across which the dam was built has its rise in the springs near the top of the mountain lying along the west side of the town, and after reaching the valley enters Dog River, in the town of Northfield, and flows thence through the Winooski River into Lake Champlain. Another brook comes down the east hill, turns toward the south, enters White River, and thence empties into the Connecticut.

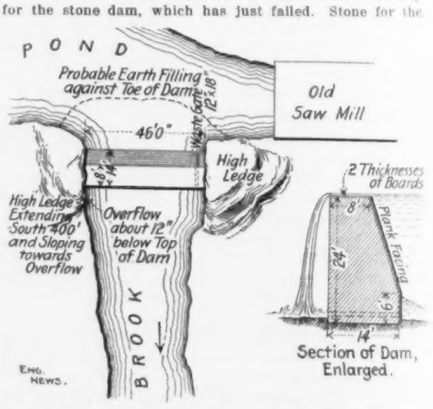
From the dam the brook flows directly toward the station, and is turned abruptly toward the north by the railroad bank, and follows the bank closely for a half mile.

Twice within the memory of the writer the water has been so high in the brook as to divide and follow the track south as well as north, thus discharging its waters to Lake Champlain and the St. Lawrence River, and also to the Connecticut River and Long Island Sound.

A wreck of the Montreal night express from Boston occurred, probably between 1867 and 1870, not far from the railroad station, when a section of track about 50 ft. long was washed out, and the next morning the engine lay on its side half buried in the swamp east of the track. The baggage car and one or two others left the rails, but did not tip over.

A small wooden dam was built on this site, about 1833, and was carried away later; after which a substantial dam of logs, with planking on the water side, was built. I saw water falling over this dam in the spring of 1863, and recollect distinctly the fascination it had for me as a child.

About 1870, this wooden dam was removed to make way for the stone dam, which has just failed. Stone for the



Sketch Plan and Section of Dam at Roxbury, Vt., That Failed on April 1, 1903.

dam was quarried from the little island near the site, and a small hand derrick took it from the quarry and landed it on the dam. The stone was of a gray, slaty formation, and was very good building stone. It was all laid dry. The bed of the brook was of good gravel and sand, well mixed, and this was excavated about 2 ft. below the natural channel, and the bottom course laid on the gravel bed.

The dimensions of dam are shown by the sketches. The figures are taken from a letter in answer to inquiries made by me about ten years ago; and may have been copied from the original plan, if any such plan was ever made. The letter referred to says "Built straight across. Should have been laid bulging up stream." This suggests that there may have been a plan; and also clears the engineer. I remember being on top of the dam a few years after it was built, and was greatly surprised to see the

open joints in the cover boards or apron at the lower edge of dam. The joints in the covering boards were tight at the up-stream edge, but at the down-stream edge they had opened not less than 2 and probably 3 ins. This indicates that the crest had moved down stream about 6 ins., and perhaps more than that. A letter just received from an old friend says: "I think the dam had gradually worked its way down stream, say 4 or 6 ins. in the center." About 20 years ago a backing of earth was applied to the up-stream face of the dam, said to have been done to stop leaks. A year or so ago the dam was repaired and all leaks stopped. These repairs consisted of new planking, cement, and quite a little tarred paper near the top, and a new apron on top of the dam. Leaks were noticed at north end of dam just over the waste gate, but were not considered larger than had previously appeared years before. "They were going to repair it in an hour or so from the time it went out."

At time of failure the water was overflowing dam 3 or 4 ins. deep. The pond was clear of ice. There were no logs floating in pond. No blasting was being done in the vicinity. I have seen water pass this dam more than 12 ins. deep on the crest.

My correspondent states that "the dam gave way at the north end, about 6 or 8 ft. from the top," and then when once started, it must have gone like an earth bank, as there are only "a few large stones left at bottom of the foundation. Large stones were carried about 200 ft. down stream by the flood."

Why did this dam remain in service thirty years, instead of going down stream within three years from the date of its completion?

W. P. Snow, M. Am. Soc. C. E.

Auburndale, Mass., May 20, 1903.

Notes and Queries.

F. T. Darrow, of Plattsmouth, Neb., wishes references to street paving in which the center of the street is depressed and acts as a gutter. He says:

I understand, of course, that tropical cities having very narrow streets use the middle of the street as gutter, but information concerning wide streets (50 to 60 ft. curb to curb) and in temperate climates, as to the amount of depression, etc., is desired.

A. V. Jillings, of Dallas, Texas, asks:

Can you give me the name of any recent publication on briquetting lignite or brown coal? Also the names of manufacturers of presses and machinery for such purpose?

An excellent compilation of information on this subject is contained in a recent number of "Special Consular Reports," dealing with the subject "Briquettes as Fuel in Foreign Countries." This may be obtained, free of charge we believe, by addressing : Chief, Bureau of Foreign Commerce, Department of State, Washington, D. C.

ANOTHER BLAST DONE IN VERSE.

Our recent versified contributions on "Meest' McDonough's Blas' " and "The Woes of the Section Boss" have encouraged a correspondent at Deadwood, S. D., to put into verse a recent occurrence in the Black Hills, near Keystone, on an extension of the Burlington & Missouri River R. R. This is the story as told in the vernacular by the foreman—doubtless with some of the most lurid language modified:

Ye see we'd got the blast all set,
Yelled "FIRE!" an' the men all routed;
When I looked an' there was a hobo yet,
Close by, an' so, I shouted.

Hi! Git back there! You'll git hurt!
Hump yerself quick you stranger,
Blast's a goin ahind that dirt,
Run you! Man! You're in danger.

Git rite out from hind that tree.
Its a hundred kags o' powder.
FIRE! Ye tenderfoot! Hear Me!
FIRE!! Can't yell no louder!

FIRE!! RUN QUICK!! Ye infurnell fool!
'F I had a rope I'd rope 'im.
Too late now; jump in thet pool,
Ahind thet rock. Git soakin'.

'Twant no use fer me ter yell.
It didn't pay expenses,
Some folks needs a dose o' hell,
Afore they gits ther senses.

Sez he "Yer can't guy me thet way,
I've seen blasts fore this un;"
I'm ahind this tree, an' here ter stay
Yu go an' soak some fresh un."

"I'll resk one eye an' see er go
I guess the tree'll stan' it.
Shet up an' stop yer swearin' so
Ther 'casion don't demand it."

RIP! CRACK! BOOM! Ther sky turned brown!
The rocks an' dirt jest flyin'.
Thet tenderfoot, wer layin' down,
The tree, wer gone a skyin'.

"Thets how 'twas when first I saw
Ther smoke an' things a clearin'.
Side o' his head wur turrible raw.
An' jest one eye appearin'.

Th' doctor said they had ter take
A half a pan o' gravel,
Out o' one side er that air jake,
Afore they let 'im travel.

They turned 'im loose some time this fall,
His looks wa'nt none ter brag of;
An' eye, an' arm, an' a ear, was all,
They did'nt take no leg off.

NOTES FROM THE ENGINEERING SCHOOLS.

STANFORD UNIVERSITY.—The present large machine shop buildings are to be extended 110 ft. for the purpose of housing a new equipment of lathes, milling machines, drills, steam hammers, etc. This new equipment is to be used in making scientific apparatus for the laboratories of the university, and the students will make most of the new apparatus, thus effecting a large saving in cost of future equipments.

ARMOUR INSTITUTE OF TECHNOLOGY.—A four years' course in Fire Protection Engineering, leading to the degree of Bachelor of Science, will be offered, beginning Sept. 21, 1903, under the direction of Prof. Fitzhugh Taylor, formerly engineer of the Underwriters' Laboratories. A special feature of the course will be a series of lectures by prominent insurance officials, architects and contractors.

MICHIGAN COLLEGE OF MINES.—The legislature of Michigan has passed a bill appropriating $171,900 for the Michigan College of Mines, at Houghton, for the biennium beginning, next July.

The most important item of this appropriation is that of $45,000 for the construction of a Metallurgical Laboratory. The college intends to erect a substantial building for this purpose, and to thoroughly equip it for experimental work and instruction in the different classes of metallurgical processes.

Cyaniding and other wet methods of concentration will be exemplified in the equipment and electrometallurgy will receive special attention. It is intended to install furnaces of larger capacity than is usual in college laboratories.

The Board of Control of the College is taking steps to create a separate department of Ore Dressing and Metallurgy. The equipment for this department will be housed in the new metallurgical building and in the ore dressing mill now possessed by the college. A man to fill the new chair had not been selected.

Besides the amount for a Metallurgical Laboratory, the bill referred to carries an appropriation of $9,000 for extending the equipment of the department of Mining Engineering, which now occupies its new building erected last year; $4,000 for completing the equipment of the Chemistry Building, also erected last year; $2,000 for providing additional cases for the Mineralogical Museum; and $1,000 for increasing the equipment of the department of Mechanical Engineering.

ANNUAL CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The 26th convention of this association was held at the Auditorium Hotel, Chicago, on May 26, 27 and 28. It was a largely attended and very successful meeting, although the oppressive heat of the poorly-ventilated meeting room caused some discomfort and undoubtedly had some influence in checking free discussion of the subjects presented.

The meeting was called to order at 10:30 a. m on May 26 by the President, Mr. Louis A. Ferguson (General Superintendent of the Chicago Edison Co.). As Mr. James B. Cahoon, the Secretary and Treasurer, has resigned on account of ill-health, Mr. Ferguson announced that he had appointed the Second Vice-President, Mr. Ernest H. Davis, as Acting Secretary. There was no formal address of welcome on behalf of the city, but Mr. E. B. Ellicott, City Electrician, sent a copy of a resolution of welcome adopted at the meeting of the City Council on the previous evening.

The President, Mr. Ferguson, then delivered his address, touching upon a number of matters relative to the work and interests of the association.

One notable feature of the address was the statement regarding the work of the association in preventing "unfair competition." In one notable case a member of the association obtained a franchise and a contract for city lighting. The established company with which the new plant would compete appealed to the association and through its influence, financial support was cut off from the rival project and manufacturers of electrical supplies withdrew their bids for apparatus so that the rival scheme was abandoned.

REPORT ON PROGRESS.

It has been customary for the President in his address to review the progress made in electric lighting work during the previous year. At the last meeting, however, it was decided that this duty hardly devolved upon the President, who may not be in a position to do the subject justice. A Committee on Progress was therefore appointed, and this committee's report was presented by Mr. T. Commerford Martin. It was very lengthy, but only a brief abstract was read, and no discussion followed.

OFFICE METHODS AND ACCOUNTING.

This paper was by Mr. W. M. Anthony, Comptroller of the Chicago Edison Co. It set forth very forcibly the advantages of a thorough and systematic organization for "operating accounting," for small as well as large companies. The loose-sheet and card systems were described in detail, and one of the features of the paper was its reference to mechanical methods for simplifying and expediting the work. The "addressograph"* may be used to print names and addresses on the meter cards, and some companies utilize the Elliott & Hatch** and Fisher billing typewriters for this work, as well as for billing current, and for printing names on the ledger sheets, these machines being intended for all kinds of work on books. The addressograph may also be used for addressing envelopes for the bills, and when the bills are enclosed the envelopes may be sealed in the Thexton† electric sealing machine. The "comptometer"‖ or the Burroughs "arithmometer"§ may be used to compute the totals of all the ledger sheets. The paper was accompanied by a set of lithographed sheets showing the forms of bills, meter-cards, requisitions, vouchers, ledgers, etc.

In the discussion, Mr. Doherty (Denver Gas & Electric Co.) said that for printing addresses, etc., he had abandoned the addressograph (using rubber type) in favor of the linotype (using type metal). He uses the calculating machine of the Spectator Co., of New York; and considers that the Thacher calculator has many special advantages. Prof. Bemis (of Cleveland, O.) took part in the discussion in regard to the accounting of water-works and electric light plants, but on remarking that he laid no claim to being an electrician, Mr. W. W. Bean (Benton Harbor, Mich.) took him to task for writing so much on the advantages of municipal ownership of electric light plants. He declared that these writings had injured his business financially and rather excitedly remarked that he did not believe any water-works or electric light plant could be operated economically by municipalities. This sentiment was naturally received with applause, the association being composed of representatives of companies. Prof. Bemis held his own in a good-natured response, and the President poured oil on the troubled waters by stating that the association was already sufficiently on record in regard to its opinion on the municipal ownership question.

At the afternoon session, the first paper was on "The Advantages to be Derived from Consolidation of Electric Interests," by Mr. Sidney Hosmer (Boston).

BOILER AND FURNACE EFFICIENCIES.

This paper was presented by its author, Mr. A. Bement, of Chicago; an abstract of it will be given in a future issue. It had been expected that there would be a brisk discussion over the efficiencies of different types of boilers, but in this respect the discussion proved disappointing.

A paper on "Standard Transformer Voltages,"

*Addressograph Co., 179 South Canal St., Chicago.
**Elliott & Hatch Book Typewriter Co., 256 Broadway, New York, N. Y.
†Thexton Electric Envelope Sealer Co., Royal Insurance Building, Chicago.
‖Felt & Tarrant Mfg. Co., 56 Illinois St., Chicago.
§American Arithmometer Co., 2102 Washington St., St. Louis, Mo.

by Mr. John S. Peck (Pittsburg) was next read in abstract.

THE APPLICATION OF FOUR-AMPERE SERIES ARC LAMPS FOR STREET LIGHTING.

This paper was read by its author, Mr. J. Henry Hallberg (General Incorporated Arc Light Co., New York):

In 1893, the first demonstration of the successful application of low-energy arc lamps to city lighting materialized, when the New York Edison Co. equipped Fifth Ave., New York, with six-ampere open-arc lamps operating two in series on about 118 volts direct-current. This proved successful, but was expensive on account of the large original investment, low efficiency and cost of carbons and trimmings. The efficiency of the system, exclusive of generators and cables, did not exceed 76%. In order to reduce the carbon and trimming expenses, three-ampere, 118-volt, multiple direct-current inclosed-arc lamps have now been installed on Fifth Ave. in place of the low-energy open-arc lamps. The efficiency of the present system, exclusive of generators and cables, does not exceed 70%.

The commercial success of the low-energy arc-lighting systems led the city of Cincinnati to specify low-energy four-ampere alternating arc lamps for lighting the streets and alleys and for the suburbs and surrounding towns. The four-ampere series alternating inclosed-arc lamp, fitted with light alabaster inner and clear outer globes, with porcelain enamel metal reflectors and solid copper shells was adopted and installed by the Cincinnati Gas & Electric Co.

In the "underground" or down-town district, the lamps are mounted on ornamental aluminum-painted iron posts. There are two posts at each street intersection (at diagonally opposite corners), and other lamps are so placed that at intermediate points no two consecutive lamps are farther than 133 ft. apart. The lamps are placed on alternate sides of the street. On a few down-town streets the lamps are 300 ft. apart.

Each down-town circuit has a capacity of 60 lamps, and they are fed by underground lead-covered cables. There are about 1,000 lamps operating on the underground system, which is controlled directly from the generating station. About 1,100 additional lamps, operating on part overhead and part underground circuits, are also controlled from this station.

The "overhead" district, comprising equipment for 3,300 lamps, covers a large territory and is divided into three sections; each section is controlled from a sub-station, where the switching and regulating apparatus for about 1,100 lamps is located. Each substation is supplied with current from the generating station through two three-phase cables; one cable carries the load and the other can be switched in in case of a breakdown. The lamps in the overhead district are hung from 12 to 20 ft. above the street, and are in no case more than 400 ft. apart.

The larger part of this magnificent installation, comprising 90 automatic, constant-current, 60-light transformers, 90 combination static dischargers and lightning arresters, 90 60-light switch panels and 4,500 series alternating-current copper-cased arc lamps, with absolute cut-out hangers, is now completed and the first circuits have been in operation about one year.

The entire arc-lighting system operates on a three-phase, 4,500-volt, 60-cycle generator. Switching devices and automatic transformers in the generating station are arranged in three groups. Each group consists of twelve 60-light transformers, and any or all groups can be switched on either of the three phases, which arrangement permits the proper balancing of the load on the three-phase system. The commercial efficiency of the system, exclusive of generator, lines and cables, is over 91%. The initial power factor of the apparatus is between 70 and 75% at all loads above quarter-load.

The writer's experience at Cincinnati during the past year has established the following facts:

1. The open-base inner globe is safer and more economical than the closed-base globe.
2. The large metal reflector is not necessary on four-ampere series alternating-current lamps hung only 12 or 15 ft. above the street, but a small enamel reflector immediately above the arc is beneficial.
3. The initial or natural power factor of a four-ampere series alternating-current system should not be depended upon to be greater than 75%, varying between 70 and 75%.
4. The 75% power factor applies to ordinary overhead circuits. When the current is supplied underground in lead-covered cables, the capacity of such cables introduces leading currents, hence the operating power factor of the underground circuits at Cincinnati is maintained above 90%.
5. The efficiency can be maintained above 91% and the regulation still be perfect.
6. Four amperes is the lowest practical limit at which successful alternating-current arc lighting can be practiced.
7. Carbons ½-in. diameter are the most practical size to use in a four-ampere alternating-current lamp.
8. Notwithstanding the large size of the carbon (considering the low-energy arc), the regulation of the system is perfect, and there are no objectionable shadows from the carbons.
9. It requires only eight trimmers to take care of 4,500 lamps.
10. The outages or lamps requiring starting in the underground district are less than 0.25%, and in the overhead district the outages average 1%.

NOTES ON THE ENCLOSED ELECTRIC ARC.

This paper was by Mr. Elihu Thomson, but in his absence it was read by Mr. Ryan. It pointed out that while in the open arc the carbons burn with tapered ends, in the enclosed arc the combustion is reduced to a minimum, causing the ends of the carbons to remain very blunt, necessitating the production of a longer arc and the use of a higher voltage. About 65 to 70 volts are required as compared with 40 to 50 volts for the open arc.

The valuable commercial result attained by the enclosure of the arc is the saving of the cost of frequent trimming and carbon renewals. Another result is that single lamps, taking a large percentage of the voltage across the ordinary low-voltage mains, can be employed in parallel with incandescent lamps, a choking resistance being incorporated in series with the arc, to take up the excess voltage, and also to steady the current, which would otherwise be unstable. With the alternating current the waste in the choking resistance is obviated in large measure by employing, instead, inductance coils in series with the arc. The saving thus effected makes up for the comparatively lower efficiency of the alternating current arc.

The paper then described some of the details of construction of the lamp in order to check the admission of air to the globe, but not to exclude it to such an extent as to cause deposits of carbon and soot.

The economy of light production in the enclosed arc lamp cannot be expected to approach that of the open arc, for several reasons. For a given energy in the arc the current is smaller and the arc flame longer with higher voltage. This means that more of the energy goes into the flame, as compared with that which heats the carbon ends. The crater surface is therefore smaller, and as the arc flame itself is a poor source of light as compared with the hot solid carbon surface, the increased arc length in the enclosed arc contributes but little to the illuminating power. Moreover, the surrounding glass globe invariably absorbs a percentage of the light; this increases during the run owing to the partial obscuration of its walls by partially opaque deposits. The introduction of the enclosed arc lamp, however, may be said to have been of the greatest value in the extension of arc lighting upon incandescent lamp circuits in parallel. Still more recently they have lent themselves most effectively to the employment of alternating currents in arc lighting from constant current transformers, particularly for street lighting.

On May 27, the first paper presented was on "The Young Engineer in the Electric Lighting Plant," by Mr. Charles F. Scott (Pittsburg), President of the American Institute of Electrical Engineers. This was followed by an interesting discussion from managers and professors. A paper on "Tactful Relations with Customers," was then read by Mr. John W. Ferguson (Assistant Contract Agent of the Chicago Edison Co.), showing the importance of such relations in their influence upon the business affairs and prosperity of the companies. This was followed by a paper on "Relations with Employees," by Mr. Arthur Williams, of the New York Edison Co. It briefly described several relief, benefit and pension systems now in force among different companies.

At the afternoon session, a paper on "First Aids and Appliances for the Injured" was read by J. D. McGowan, M. D. Before describing the first-aid methods he exhibited a large "first-aid" package or accident case containing many things that are invaluable to the layman in applying relief to the injured; and also some articles which none but a surgeon should be permitted to touch, such as needles, sutures, etc. If a surgeon, hastily summoned, should have omitted to bring with him all the requisites for cleansing, suturing and dressing a wound, it would be very convenient to have these ready in such a compact form.

He also showed the Chicago Edison Co.'s emergency box, devised by Mr. W. L. Abbott. One of these is carried on each wagon. It contains a box of Edison ointment, a gauze bandage, a first-aid package, a hypodermic syringe, and a solution containing 1-20th grain of strychnine to each barrel of syringe. The strychnine is to be used to inject under the skin of a man who receives a shock from the high-tension wires. If a doctor is nearby it is well to have the solution ready for him; in the absence of a doctor the foreman is instructed how to use the syringe. The box is sealed, and not opened until needed. After use it is sent back to the office to be replenished.

It was voted that this paper should be published by the association in pamphlet form and issued to members for distribution among their employees.

The next paper was on "Steam Turbines," by Prof. Wm. Lispenard Robb (Rensselaer Polytechnic Institute). The discussion was interrupted at 4 p. m. by adjournment for the purpose of visiting the Fisk St. power house.

DISTRICT HEATING.

At the morning meeting, on May 28, Mr. John W. Glidden presented the report of the Committee on District Heating, relating to heating from central stations:

There are about 100 heating plants of this character in operation in the United States. Possibly 10 of these are live-steam plants. Of the remainder, 67% are exhaust steam and 33% hot-water heating plants. The accompanying table is given not because of its value, but to emphasize the condition of the heating business. You can notice a lack of information in a majority of cases. This arises from two reasons: 1, because they have not got it; and 2, because they are afraid of the damage to their capital stock if the actual conditions of their heating business became known.

Table of District Heating Plants.

No.	Investment in heating plant.	Heating revenue.	Price of coal.	Labor and fuel for heating.	Total coal.	Back pressure.	Net revenue per cent. of investment
1.	$75,000	$26,000	$1.00	$12,000	$31,536	3–15	18.7
2.	4,800	2,000	2.40	.....	.....	0–0	....
3.	12,000	3,200	1.75	.....	.....	2–5	....
4.	33,000	2,293	1.25	.....	5,838	0–3	....
5.	67,738	26,449	1.58	20,916	27,594	3–20	8.2
6.	5,000	1,000	1.25	.....	.....	0–0	....
7.	40,000	.....*	2.15	.....	.....	0–0	....
8.	15,000	6,500	1.70	3,000	8,148	0–0	25.3
9.	.....	43,000	....	14,800	.....	5–18	....
10.	16,000	3,712	2.00	.....	.....	0–0	....
11.	66,159	15,843	....	13,282	7,185	0–0	4.0
12.	30,000	3,170	2.25	.....	.....	0–0	....
13.	.....	.....	5.00	.....	.....	0–0	....
14.	48,000	10,000	.90	.....	.....	2–5	....
15.	10,000	2,642	1.35	1,414	4,950	1–3	12.3
16.	6,000	1,906	2.10	.....	3,500	1–5	....

*Just standard.

Remarks on the Different Plants: No. 1, 4, 5, 7, 8, 10 and 15—Day loads; No. 2—Water power; Nos. 3, 6 and 16—No day load; Nos. 9 and 11—Live steam only; No. 12—New plant; Nos. 13 and 14—Sore spot.

Note.—Isolated office buildings use 100 lbs. good Illinois coal per square foot of radiation during seven months heating season.

This table and the letters received by the committee show that this subject requires good, strong treatment by the Association. I visited about 20 heating plants, personally interviewed the managers and inspected the properties. Aside from the plants located in the cheap coal belts, where screenings can be delivered for about $1 per ton, and a few other plants where the gross receipts are at least 60% of the investment in mains, there is very little enthusiasm among heating managers. It appears from talks with heating managers and from the merchants' plants which are being installed, that even though it were demonstrated that the present conditions of the business would not warrant central station men in going into it, they would go into it, nevertheless, because the public has become so thoroughly convinced of the desirability and practicability of district heating, that if the central station does not occupy the territory, it will be occupied by merchants' associations. These associations will, at the same time, enter the lighting business and jeopardize the investment of the older company. It seems beyond dispute that there exists a very lively and pressing demand for heating plants.

A uniform system of accounting and keeping records, with thorough testing to show what becomes of the actual heat units sent out, would clarify the business and remove it from the field of haphazard experiments to make it an exact science. My conclusions are as follows:

1. No evidence that the business is generally profitable.
2. A lack of information among heating managers.
3. A lack of enthusiasm for the business.
4. Little separate accounting.
5. Genuine demand from the public for the services.

In the discussion it was pointed out that it is hard to get information that is definite and reliable, as the average central station manager has not the means or the apparatus for thoroughly and scientifically testing the efficiency of his plant. The necessary apparatus is expensive, and tests would have to be very carefully made. There is an enormous demand for steam heating, but at present there seems to be little money in the business, and managers are looking for some practical information on the matter. The financial outlook of any particular plant depends upon various factors: the location of the power house to the district to be served is the most important; the comparative cost of steam coal and domestic coal, and the possibility of using exhaust steam also enter into consideration. A resolution was adopted putting the investigation of the subject in the hands of a permanent committee, but the President pointed out that it is no use for the committee to enter upon such an investigation unless members of the association who operate steam heating plants are prepared to furnish full infor-

mation. If they do this, each one will receive ten times as much information as he gives.

The next paper was by Mr. Alex. Dow, on "Salt as a By-Product," describing the utilization of steam from a power plant for the evaporation of salt brine. The subject of photometry was then taken up. Prof. H. E. Clifford (Mass. Inst. of Technology) made some brief remarks on "Fundamentals of Photometry," in which he suggested that arc lamps should be rated not by their candle power, but by their distribution of illumination under conditions similar to those of their use in service. Prof. Charles P. Matthews (Purdue University) gave an outline of the work of the Committee on Investigation of the Photometric Values of Arc Lamps, the report not being yet ready for publication. The work has included tests of Nernst, direct and alternating current arc, incandescent, and Welsbach lamps and gas flames. Prof. Matthews also exhibited his integrating photometer, which eliminates the use of calculations and gives with one observation the mean spherical, horizontal and zonular candle-power. The morning session closed with a paper on "Decorative and Sign Lighting," by Mr. Arthur Williams (New York Edison Co.), the report being illustrated by a large number of photographic reproductions of signs and decorative work.

METHODS OF VARIABLE SPEED CONTROL.

At the afternoon session, Mr. William Cooper, of Cincinnati, presented a paper on "The Relative Advantages of Electrical and Mechanical Methods of Variable Speed Control for General Power Service." Of this we shall give an abstract later, but the discussion turned mainly upon the relative advantages of gas engines and electric motors for operating shop machinery. Mr. Cooper mentioned certain figures of cost of gas engine service which aroused wrath among some of the electrical men, and after some discussion a resolution was passed (most of the members not voting at all) that Mr. Cooper's remarks as to prices should be struck from the records. Several members cited instances to show that the competition of gas engines with electric motors is not only or even principally in running cost, the electric motor possessing many advantages in reliability and general applicability to the service.

The next two papers were on "Theft of Current," by Mr. Robert L. Elliott, of Chicago; and "Lost and Unaccounted-For Current," by Mr. L. G. Van Ness, of Lincoln, Neb. Papers read by title were: "Development of Electric Power Stations," by Prof Elihu Thomson, of Lynn, Mass.; and "Light and Illuminating Engineering," by Mr. W. D'A. Ryan. The latter was illustrated by colored plates showing the varying appearance of the same samples of colored silks, when viewed under the light of Nernst, arc, incandescent and Welsbach lamps.

Profiting by the experience of last year, when the convention was unable to get through the program, the number of papers and reports was kept within reasonable limits, and the program was followed out very closely. The "Question Box" feature has developed to such an extent that it was impossible to present the questions for discussion at the meeting. Instead of this the 257 questions and the replies (one or more in each case) were printed in a pamphlet of 200 pages. Unfortunately the only index is a list of questions covering 13 pages, and it is necessary to read this over to ascertain what subjects are included.

EXHIBITS AND ENTERTAINMENTS.

The multitudinous exhibits of electrical apparatus and supplies were not concentrated, but pervaded the entire hotel, being scattered through the rooms of the various representatives of supply houses, where refreshments and "souvenirs" were liberally distributed to the visitors. The effect of the exhibits is probably very small under this arrangement, as members do not care to go from room to room on various floors, and will often pass by a small crowded room without attempting to enter. Where there is a concentration of exhibits in a hall, etc., many of them can be seen at once, and many of them will attract accidental or involuntary attention. A feature of the conventions of this association is that entertainments and excursions are not allowed to interfere with the business meetings. The only excursion was to the new Fisk St. power station of the Commonwealth Electric Co., for which the meeting was adjourned one afternoon at 4.15 instead of 5 p. m. Entertainments were, however, provided for the ladies of the party.

OFFICERS.

The following officers were elected: President, Charles L. Edgar, Boston, Mass.; First Vice-President, S. V. Livermore, Winona, Minn.; Second Vice-President, J. W. Lieb, Jr., Brooklyn, N. Y.; Secretary and Treasurer, Ernest H. Davis, Williamsport, Pa. The next convention is to be held at St. Louis, Mo., in 1904.

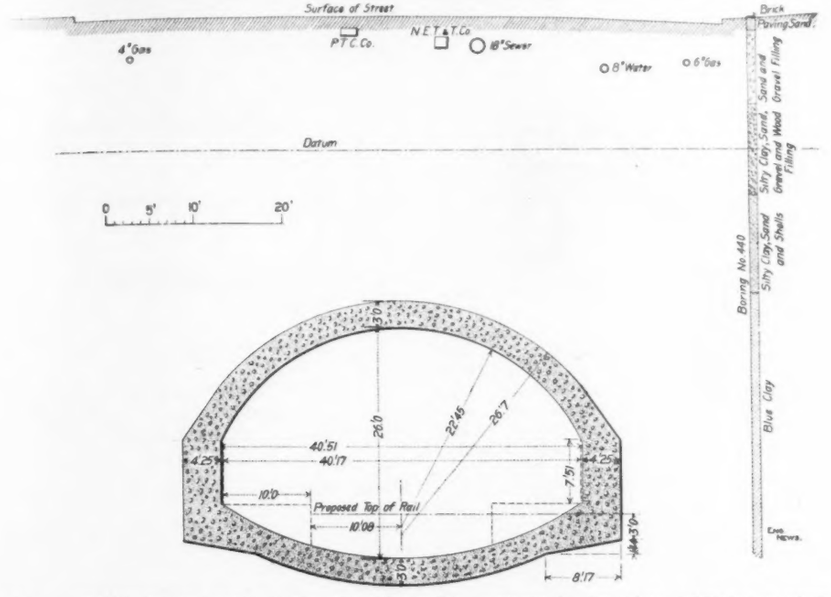


FIG. 1. TRANSVERSE SECTION OF ATLANTIC AVE. STATION FOR EAST BOSTON TUNNEL.

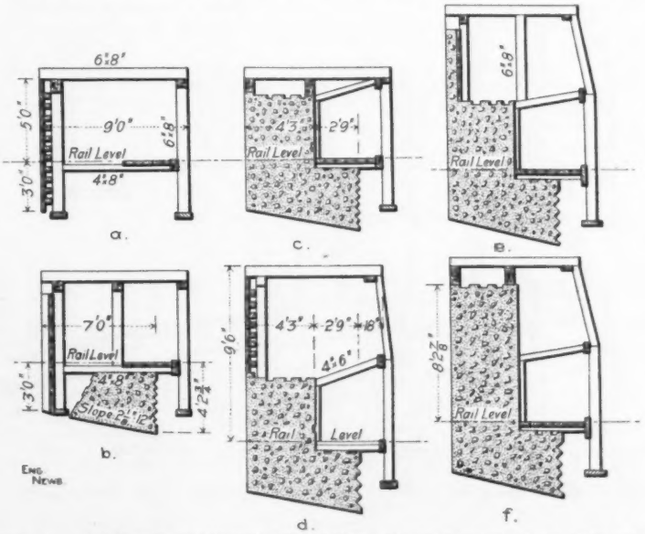


FIG. 2. DIAGRAMS SHOWING SEQUENCE OF OPERATIONS IN BUILDING SIDEWALLS OF ATLANTIC AVE. STATION.

AN INTERESTING EXAMPLE OF WIDE ARCH SOFT GROUND TUNNELING.

Atlantic Ave. Station Tunneling.

An unusually interesting task of wide arch soft ground tunneling is being performed in building the Atlantic Ave. station of the Boston Subway extension to East Boston, Mass. This extension runs from the Scollay Square station of the present subway, underneath Boston Harbor to a terminus at Maverick Square, East Boston, and the Atlantic Ave. station is the last on the line before it plunges under the harbor. It is deep underground and below the water level and it connects at each end with the standard double-track tunnel section which is 23 ft. 8 ins. wide and 20 ft. 8 ins. high. Structurally the station consists of two parts, one being the wide arch which encloses the double tracks and the two platforms, and the other being the vertical shaft by which communication is had with the street. The entrance shaft is rectangular, and 40 × 57½ ft. in plan; it will contain elevators, stairways and other station equipment and it is being built by sinking pits from the surface. The arched portion of the station is being constructed in tunnel working from the point where the double-track subway coming from Scollay Square meets the end line of the station arch. Up to this point the tunnel was driven by means of side drifts and a roof shield, but at the beginning of the wide station arch the shield was stopped and the work is being continued by timbering methods. A cross-section of the station is given in Fig. 1. Its length is 150 ft.

MATERIALS PENETRATED.—The materials to be penetrated, as developed by a boring made about mid-length of the station, are shown by Fig. 1. It will be observed that the location of the tunnel came entirely within the blue clay stratum. Except that occasional pockets of sandy clay have been found within the blue clay and that the stratum of silty clay, sand and shells has not yet been encountered, the work, which has progressed for about two-thirds the length of the station, has not so far disclosed material which differs greatly from that indicated by the boring. The clay in which the bulk of the excavation is being performed is normally very solid and compact, and has to be loosened by picks and mattocks, but it is all below water level and about 18 lbs. air pressure are employed to prevent seepage of water into the excavation.

CONSTRUCTION OF SIDE WALLS.—The first operation in constructing the station tunnel is the building of the side walls. The mode of procedure is shown by the drawings of Fig. 2. A

bottom drift is first opened and timbered as shown at (a). The next step is to remove the side boarding and replace it by a lagging of corrugated boards, behind which a 6-in. concrete wall is built as shown at (b). A portion of the side wall and invert are then placed and carried up to near the top of the drift, as shown by Fig. 2, (b) and (c). A second drift is now started above the first and timbered, as shown by Fig. 2 (d). In this drift as in the first the side boarding is removed and replaced by lagging, behind which a 6-in. concrete wall is built, as shown at (e), Fig. 2. The side wall is then carried up to the top of this drift, as shown by Fig. 2 (f). This operation completes the wall to the springing line of the arch. The walls are of concrete and are constructed on both sides simultaneously as described. It will be understood of course that the side wall work is a continuous operation. At the front or advance end the operations indicated by section (a) are being performed, a little behind come the operations of section (b), and then follow the operations of sections (c), (d), (e) and (f) in the order named. It will be seen from the sections of Fig. 2 that the bottom drift has a spoil car platform at track level and is sufficiently wide to accommodate cars at one side of the completed wall.

CONSTRUCTION OF ROOF ARCH.—The construction of the roof arch of the tunnel follows shortly behind the completed side wall work shown at (f), Fig. 2. The mode of procedure is shown in diagram by Fig. 3. A crown heading, A, 8 ft. wide and 7½ ft. high, is driven and timbered by wall posts, surmounted by transverse caps. Over these caps are inserted four sheet steel poling boards. Ahead of heading A and below it is driven a second heading, B, which is 8 ft. high and 6 ft. wide. This heading serves for the removal of the spoil. From heading A a drift is carried right and left toward the haunches, steel poling boards being inserted and braced in position by radial struts from the core beneath. From each haunch work is also begun removing the drift, D, working toward the springing lines. Drift D is roofed with steel poling boards and strutted exactly like drift C. When drifts D and C meet an annular gallery has been opened the full width of the roof arch and the depth of one poling board or 30 ins. In this gallery the roof arch is built on centers and in 2½-ft. sections.

Turning now to some of the details of the work, it may be noted that the timbering of the headings A and B, and the manner of carrying the ribs of the arch center are sufficiently shown by Fig. 3. The steel poling boards are of the dimensions and construction shown by Fig. 4. Each plate is 30 ins. long and 24 ins. wide and has flanges formed by attached angles on all four sides. These flanges are drilled for bolts, and serve to connect adjacent plates. In operation the heading, A, is driven ahead at the top far enough to permit the four crown plates to be inserted endwise. Generally the full face of A can be opened and the head as an advance of 2 ft. has been made a roof plate is inserted and bolted in place and strutted up from the core. In this way the work progresses from the crown toward each haunch. Practically the same operations take place in working from the haunches downward to the springing lines in openings D. Normally the advance face is kept about 10 ft. ahead of the arch ring, as shown by Fig. 3.

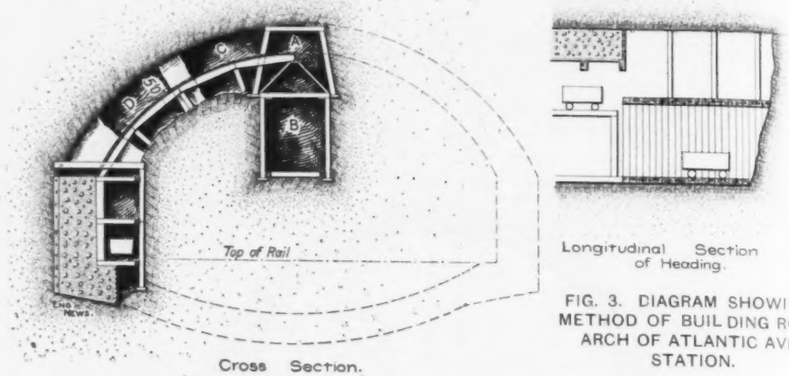


FIG. 3. DIAGRAM SHOWING METHOD OF BUILDING ROOF ARCH OF ATLANTIC AVE. STATION.

The removal of the spoil from the roof arch opening is accomplished partly by the muck cars running in heading, B, and partly by those running in the side drifts. All the material from headings A and B and the lateral drifts, C, is removed through heading B. The cars in the side drifts take the spoil from the openings D. It will be observed that the spoil cars in no way obstruct the annular opening in which the arch is being built and where excavation and timbering are in progress.

The arch ring construction calls for but little mention. The centers were built in 30-in. sections and the lagging is left off the ribs at the crown. A special floor is constructed for the concrete cars as the arch work progresses and at a level of the top deck of shield through which the cars must pass on their way down through the tunnel. This is about 2 ft. below the floor of heading A and lessens the head-room in heading B by this amount. Cars are dumped on this floor and the concrete shoveled into arch. About 30 batches are required for an arch and the average time for completion on stint work is six hours. Each section of arch is concreted by working from both springing lines upward until the crown segment or key is reached and this is built by passing the concrete in endwise of the arch over the forward rib. The steel plates are left in place and form a part of the permanent structure. A 5-ft. section of arch, 30 ins. each shift, is concreted every 24 hours.

WORKING PLANT.—The working plant employed in constructing the Atlantic Ave. station arch was the same as that employed in building the 600-ft. section of approach tunnel, and is fully described in the section of this article which treats of the work on Section C of the East Boston extension of the subway.

GENERAL REMARKS.—The work which has been briefly described above was visited by a member of our editorial staff on April 24. The various operations were then in full swing and the side walls and roof arch were being advanced at the rate of 5 ft. each day. Two shifts of about 100 men each were being worked each day, the duration of each shift being ten hours. Normally there are a gang of excavators, a gang of carpenters and a gang of concreters for each of the drifts for each side wall, or twelve gangs for the side wall work. Three gangs of men, namely excavators, carpenters and concreters work on the roof arch. In addition there are the spoil car and concrete car gangs and the men operating and attending the mechanical plant. The gangs at the face work by stint, the task before them being to complete 2½ ft. of side wall and roof arch each shift. Whatever time they cut off from the period allowed is their own, and the result of this arrangement is observable in the activity with which operations proceed. A noticeable feature of the work was the thorough systematization of the various operations, the lack of confusion and interference between the different gangs, and the unusual cleanliness of the workings from spoil, timbers and debris of any sort.

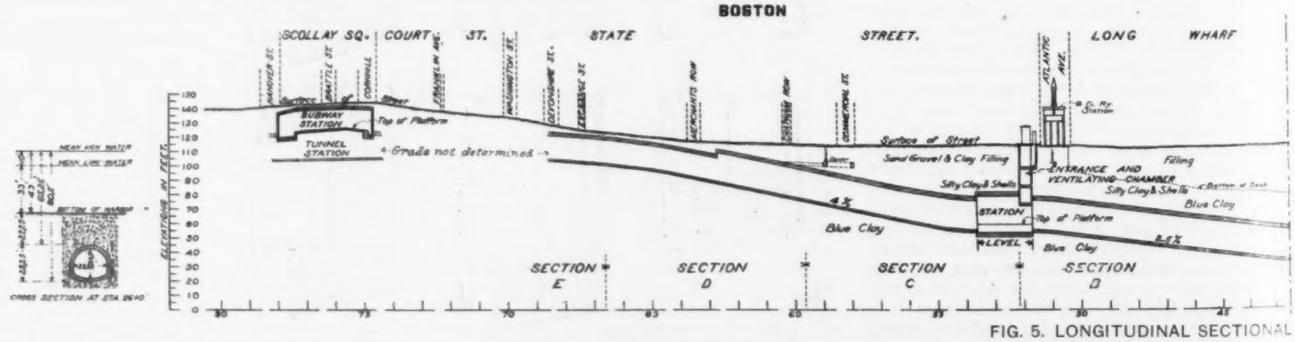


FIG. 5. LONGITUDINAL SECTIONAL

frame set at once to carry the forward ends of the plates, but in material where this is not practicable the plates can be inserted bit by bit and one at a time by posting down from the roof. So far the material has been such that this piecemeal work has not been necessary. When the four crown plates have been placed and bolted together and to the plates to the rear, the lateral enlargement of heading A is begun, taking out a section about 5 ft. high and 30 ins. wide. As soon

CONSTRUCTION OF INVERT.—The operations previously described have a large center core of clay to be removed and the invert to be constructed. This work will not be begun, however, until the side walls and roof arch have been nearly completed. The plan now proposed is to stop the arch construction within 8 or 9 ft. of the end of the station arch where it emerges into the entrance shaft. This will have a wall of ample thickness to hold the air pressure, under which the core can be removed and the invert built. The core removal will be accomplished by breaking down the end face in two or more benches and taking the spoil out through the air locks. The invert will be built in short sections as the core is cleared away. The final operation will be the completion of the short remaining lengths of side walls and roof arch under air pressure as long as the face wall is capable of holding the air, and after that by working under atmospheric pressure.

The 600-ft. Approach Tunnel.

The immediate approach to the Atlantic Ave. station from the west consists of 600 ft. of double-

track tunnel. This approach tunnel and the tunnel portion of the station are officially designated Section C. The entrance shaft portion of the station and the tunnel under the harbor to East Boston are comprised in Section B, with the exception of the open cut approach work at the East Boston end, which is designated as Section A. Between the west end of Section C and the Scollay Square station are Sections D and E. This general layout of the work is shown by Fig. 5. The

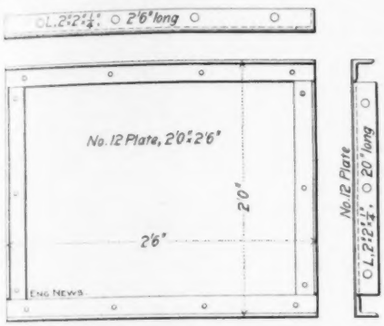


Fig. 4. Details of Steel Roof Plates Employed in Tunneling for Atlantic Ave. Station.

work of constructing Sections A and B of the tunnel was fully described in our issue of June 23, 1902, and with the exception of the entrance shaft to the Atlantic Ave. station has all been done from the East Boston end. In the following paragraphs the work of constructing Section C, or, rather, that portion of the section which consists of standard tunnel, is described:

Briefly described, Section C of the East Boston tunnel extends from about the middle of India St. east along State St. for a distance of 750 ft., and includes the tunnel portion of the Atlantic Ave. station, which has already been described. The tunnel is 23 ft. 8 ins. wide and 20 ft. 8 ins. high; the invert is 24 ins. thick, the roof arch 31 ins., and the side walls from 31 ins. to 33 ins. The lining is entirely concrete masonry. Sections D and E of the tunnel being of shallow depth, it was planned to build them by the cut-and-cover process. This process was, however, not practicable for Section C, because of its depth, and it was planned for construction by tunneling starting from a shaft at the west end, which was at India St.

Bids for constructing Section C of the tunnel were received on Feb. 25, 1902, but were deemed too high and were rejected. It was assumed by the Transit Commission that the reason for the high bids was the risk of settlement of adjacent buildings, and it determined to undertake the experiment of awarding contracts under the condition that the risk was assumed by the city. Under these conditions work was begun on the section by Gow & Foss and was afterward taken over by Patrick McGovern, Contractor, 37 Maywood St., Boston, Mass., who retained Mr. Charles R. Gow as engineer and practically the whole working organization of Gow & Foss.

INDIA ST. SHAFT.—Work on the shaft at India St. was begun on March 4, 1902, and the shaft was completed to grade on April 19, 1902. This shaft was 34 x 40 ft. in plan and was 42 ft. deep. The first 20 ft. of the depth was through filled ground, which carried much water, and to keep this water from the shaft a trench was excavated around it to a depth of 20 ft. and was filled with clay. As soon as the shaft was completed the invert was built at its bottom and the side walls were carried up to within 1 ft. of the springing line.

TUNNEL CONSTRUCTION. — The method adopted for constructing the tunnel of Section C was essentially that employed in constructing Section B, which was described in our issue of Jan. 23, 1902. Briefly described, it consisted in opening a side drift on each side wall line and building within them the side walls to a height within 1 ft. of the springing line. These drifts were 8 x 8 ft. in cross-section and were timbered solidly with 8 x 8-in. spruce legs and caps. The legs were set on 4 x 12-in. blocks of hard pine. On the side walls a segmental steel shield was mounted and pushed ahead to excavate the roof arch. These operations left a core of earth to be removed and the invert to be constructed after the side walls and roof arch were completed. The core was carried along with the shield, only the invert remaining to be done. The side wall drifts were extended about 150 ft. from the shaft under atmospheric pressure and afterwards by using compressed air, the air locks being installed a short distance east of the India St. shaft.

WORKING PLANT.—The tunnel proper in Section C is only 600 ft. long and required a shield, centering, and air locks that would have to be made expressly for it and other expensive plant that would not probably be available in the hands of any contractor who would bid on the work. If a contractor should purchase all of this plant it might be of little value to him after the contract was completed. The commission might, however, find it necessary for completing Section B if any serious delay should occur in the progress of that work, and it might also be available in other ways. The Transit Commission could therefore better afford to purchase than a contractor, and it appeared probable that if the most expensive and unusual part of the plant was provided by the commission, it would invite lower bids than would otherwise be obtained. The commission accordingly did so provide. Some details regarding the plant are given in the following paragraphs from the annual report of the Transit Commission for 1902:

The roof shield was built by the James Russell Boiler Works Co., South Boston, who also built the shield for Section B and that for Section 6 of the Boston Subway. The shield is ubstantially the same as that used on Section B except in the following particulars: The rear curved girder is greatly lessened in height at the crown (see Fig. 6) to facilitate keying up the concrete arch; the I-beams under the shield and over the side walls of the tunnel are 9 ins. high instead of 6 ins.; the rollers under the I-beams are 6 ins. high instead of 8; the shield is 13 ft. long instead of 12 ft. 6 ins.; the hydraulic jacks are of a different type and make.

Weight of shield without the hydraulic jacks and feed pumps, about 52 tons. Diameter of shield, 28 ft. 10 ins. Sixteen hydraulic jacks (for pushing shield) made by the Watson-Stillman Co., of New York. Three air locks, each 6 ft. in diameter and 30 ft. long, built by E. Hodge & Co., of East Boston.

The India St. power plant was furnished complete, except the building, set up and put in operation by the Ingersoll-Sergeant Drill Co. The principal items include the following: Two straight line compressors, each of a nominal capacity of 800 cu. ft. free air per minute compressed to 120 lbs. pressure per sq. in. and having its air ends compounded. Two straight line compressors, each of a nominal capacity of 1,000 cu. ft. free air per minute compressed to 40 lbs. pressure per sq. in. Two receivers into which the compressors deliver the compressed air, each 4 ft. 1 in. diameter and 12 ft. high. One receiver to be used in the tunnel, 4 ft. in diameter and 8 ft. high. Three horizontal return tubular boilers 6 ft. in diameter, with tubes 18 ft. long, placed in a brick setting, with gage-cocks, water glasses, safety valves, tools to run and care for them, and all other appliances, fixtures and mountings usually furnished. Boilers are to be run at 100 lbs. pressure per sq. in. One smoke pipe 5 ft. in diameter and 130 ft. high.

The plant also includes a feed water heater, boiler feed pumps, water tank, smoke flue, and all gages, tools, oil

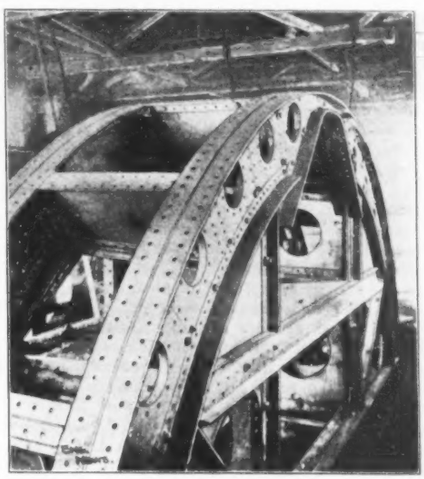


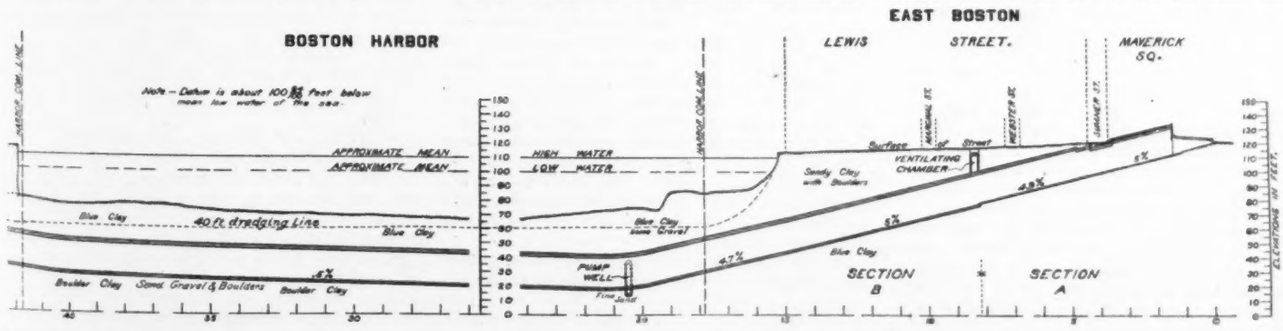
Fig. 6. View of Top and Rear End of Roof Shield for Section C of East Boston Tunnel.

cans, wrenches, etc., etc., necessary to operate the plant and keep it in good running order. The piping and valves are so arranged that any possible connection between the boilers and the high or low compressors can be made, and that any boiler or any compressor can be shut off without stopping the running of any one of the others, and so that the compressors can discharge into either receiver.

Twenty-five mud cars built of oak, with hinged sides. Capacity, 25 cu. ft.; gage, 18 ins.; wheels, 10 ins. diameter. Four concrete cars—steel box end-dump cars; capacity, 22 cu. ft.; gage, 18 ins. Fifteen tons rails; 16-lb. T-rails in lengths of 6 m., or 19.65 ft., so they can be carried through the air locks. These were ordered and delivered from Germany on account of the long time for delivery demanded by manufacturers in this country. Thirteen switches. Seven right-hand and six left-hand switches built in one piece to an 18-in. gage. Were delivered from Germany with the rails. The foregoing cars, rails and switches were furnished by Sherburne & Co., of Boston.

Elevator. One platform cage 5½ x 6½ ft. rated to carry a load of 6,000 lbs., equipped with counterweights and one set landing dogs. The elevator is operated by a hoisting engine with two cylinders 9 ins. x 10 ins. and a drum 33 ins. in diameter. Elevator and engine furnished by National Contracting Co., of Boston. Winding engine, double drum, to operate mud cars inside the air locks. Has two cylinders 7½ ins. x 10 ins. and two drums each 24 ins. in diameter set tandem. Reversible link motion. Will be operated by compressed air. Furnished by Lambert Hoisting Engine Co., of Newark, N. J. Winding engine, single drum, to operate concrete cars inside the air locks. Is a duplicate of the double drum engine except that it has but one drum. This engine is to be operated by compressed air. Furnished by Lambert Hoisting Engine Co., of Newark, N. J. One concrete mixer: No. 3 Iroquois mixer; capacity, 1 cu. yd. per batch. Requires a 35-HP. engine to operate. Mixer furnished by the Warren-Burnham Co., New York city.

CONTRACTOR.—The contractor for Section C of the tunnel was Patrick McGovern, of Boston, Mass. Mr. Charles R. Gow was engineer for the contractor, A. E. Wearing was Day Superintendent and Arthur Negus was Night Superintendent. We are indebted to the contractor for the bulk of the information from which this article has been prepared.



PROFILE OF EAST BOSTON TUNNEL.

THE UNION ENGINEERING BUILDING: STATUS OF THE ENGINEERING SOCIETIES.

In the discussion concerning the project for a union engineering building in New York city, based on the offer by Mr. Carnegie of $1,000,000, frequent reference has been made to the relative standing of the various societies directly and indirectly concerned.

It has appeared to us, therefore, that a brief statement concerning each of these societies, its membership, annual income, accumulated property, etc., may be of interest at this time, since few engineers have any accurate knowledge of these engineering societies outside the one or two in which they hold membership.

Our readers will recall that Mr. Carnegie's offer was addressed to four national engineering societies, and a New York social club composed of engineers, viz., the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers, and the Engineers' Club (of New York city). It is generally understood, however, that the gift will be turned to broader account than that directly specified. The building will probably be so arranged as to furnish quarters for all American engineering societies of national scope, or at any rate for those which naturally choose New York city as a permanent headquarters. The above four societies do not cover the whole field of engineering societies, though they are the most general and most important. Among other societies which are national in their scope (and which are without a permanent home at present), are such organizations as the American Society of Testing Materials, the American Society of Heating and Ventilating Engineers, the Society of Naval Architects and Marine Engineers, the Society for the Promotion of Engineering Education, and the American Electrochemical Society. The Carnegie gift will not serve its best and broadest purpose if it does not offer a home to such societies as these, but confines itself to the beneficiaries stated in the letter of presentation.

In comparing the condition of different societies the following items are important: (1) Membership, total and classified, required qualifications, dues charged. (2) Income and expenditures. (3) Present total resources. (4) Government. (5) Work of the society, number of meetings held each year, etc. These items are briefly discussed in the following:

AMERICAN SOCIETY OF CIVIL ENGINEERS.—(1) The total number of members in February, 1903, was 2,725, composed of 1,570 Members, 728 Associate Members, 262 Juniors, and an aggregate of 163 Honorary Members, Associates and Fellows. It will be seen that well over one-half of the total membership is of the highest grade (Member). The qualifications for the two principal grades are: A Member must be a professional engineer, at least 30 years old, who has exercised his calling for at least ten years, and at least five years in a responsible position. An Associate Member must be a professional engineer, at least 25 years old, with at least six years of experience and at least one year in a responsible position. Members and Associate Members are elected by the society at large, on letter ballot after approval by the Council; seven votes reject, but there may be a reconsideration, and a constitutional amendment is now pending which will make 20 negative votes necessary for rejection. Members are admitted to other grades by the Board of Direction. The initiation fees are $30 for Members, $25 for Associate Members; the annual dues are $15 for both grades, with an additional $10 for residents within 50 miles of New York city.

(2) The income of the society for the year 1902 was $62,497.85. The expenditures for the same year were $52,193.77.

(3) The net assets of the society in January, 1903, including the library, etc., were $300,278.05.

(4) The society is governed by a "Board of Direction," which controls all the regular work and may initiate special work, by committees, etc., after authorization by the society at large through letter ballot. The officers of the society are elected by the society at large after recommendation by a committee distributed over the whole country, the country being divided into seven districts for this purpose. The nominations are made with due regard to geographical distribution over the different districts.

(5) The society holds semi-monthly meetings in New York city during nine months, and also two general meetings per year, the annual business meeting in New York city, and the summer convention, which is held in some other part of the country. It publishes its papers in advance of their presentation, in monthly volumes of "Proceedings," and also publishes the papers and the discussions on them in semi-annual volumes of "Transactions."

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—(1) The total membership at the beginning of 1903 was 2,349, made up of 1,606 Members, 174 Associates, 551 Juniors, and 18 Honorary Members. Thus nearly two-thirds of the whole membership is of full grade. A Member must be a competent designer or constructor or able to take responsible charge of the work, and at least 30 years old. An Associate must be 26 years old and must be competent to take charge of work. The initiation fees are $25 for Members and Associates, the annual dues are $15 for both grades. Applications, with proper references, are passed upon by the Council and voted on by the society at large; seven negative votes reject, in case of both members and Associates. The society is about adopting a new constitution by which 2% of the votes cast will be required to reject an applicant.

(2) The income* for 1902 was $45 850.32; the disbursements* were $40,504.45.

(3) The net assets in September, 1902, were $76,423.81; this sum includes the resources of the Mechanical Engineers' Library Association, a subsidiary corporation which holds the library and part of the house of the society.

(4) The society is governed by a Council; special committees are appointed by the President after the work is authorized by the society. The officers are nominated by a special committee, but independent candidates may be nominated. Election is by letter ballot.

(5) The society holds two conventions per year, one being the annual meeting held in New York city. During the past year monthly meetings have been held at New York, but the papers and discussions were not brought before the society at large by publication. An annual volume of "Transactions" is published.

AMERICAN INSTITUTE OF MINING ENGINEERS.—(1) The membership in January, 1903, was 3,267, made up of 3,100 Members, 157 Associates, and 10 Honorary Members. Nearly the whole membership is thus of full grade. A Member must be a professional mining engineer, geologist, metallurgist or chemist, or a person practically engaged in any of these fields. An Associate may be any suitable person desirous of being connected with the Institute. After approval by the Council, candidates are elected by letter ballot; three-fourths of the votes cast must be favorable. There are no entrance fees required; the annual dues are $10 for both Members and Associates.

(2) For the year 1902 the income of the society was $44,409.49; the expenditures were $37,544.02.

(3) The total assets of the Institute are not made public. They have been estimated as high as $100,000, but the cash property will probably not exceed $30,000.

(4) The Institute is governed by a Council, which has authority over the entire working of the organization. Nominations for officers are made in two lists, one by the Council or its committee; the other made up from independent nominations sent in by members. The election is by letter ballot.

(5) The Institute holds one annual meeting and such others as the Council directs. Usually two meetings other than the annual meeting are held each year. The papers presented at the meetings are printed and distributed in advance, and papers with discussions are printed in an annual volume of "Transactions." Occasionally the Institute has published special volumes on subjects connected with mining.

*Including income and expenditures of the Mechanical Engineers' Library Association.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—(1) In April, 1903, the total membership was 2,229, made up of 417 Members, 1,810 Associates, and 2 Honorary Members. The largest proportion of the membership is in the Associate grade. A member must be 27 years old, must have previously been an Associate, must be a professional electrical engineer or a professor of electrical engineering, or must have done important original work in electrical science. An Associate may be any one interested in or connected with the study or application of electricity. Members and Associates are elected by the board of managers, in which two votes (out of 12) will reject. The entrance fees are $10 for Members and $5 for Associates; the annual dues are $15 and $10, respectively ($10 and $5 for foreign members and associates).

(2) During the year 1902 the Institute received $30,181.25, and expended $29,559.67.

(3) The total net assets, including the library, at the end of the year 1902, are $32,192.05.

(4) The government is in the hands of a board of managers, which initiates and directs all the work of the Institute, except that the president appoints the existing committees at the beginning of his term, subject, however, to change by the board of managers. Nominations of officers are made by the board of managers or its committee, on the recommendations of members by letter of nomination. The vice-presidents are selected with reference to due geographical distribution. Election is by letter ballot.

(5) The Institute holds monthly meetings at New York, and one annual convention. The annual business is transacted at the regular monthly meeting for May.

During the past year the Institute has organized about a score of local branches, at different points throughout the country, at which monthly meetings are also held. The papers read here are the same as those presented at the New York meetings. The papers and discussions are printed in a monthly pamphlet and also in an annual volume of "Transactions." In addition to this work the Institute does a great amount of committee work, such as compiling standard rules, standard nomenclature, investigating special subjects, such as "High-tension Transmission," etc.

The preceding data cover the four societies to whom Mr. Carnegie's offer was addressed. Briefer notes are given below in regard to some of the other societies referred to above.

AMERICAN ELECTROCHEMICAL SOCIETY.—This society was formed only a year ago, but is active and growing and promises to become an important national society. It has about 500 members; the qualifications for admission have not yet crystallized into anything more than requiring interest in the work of the society. The initiation fee and annual dues are each $5. Two conventions per year are held, one of them being also the annual business meeting. Papers and discussions are printed in an annual volume of "Transactions." The society has assets of about $1,000.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—This society, organized in 1892, has about 400 members, 300 Associates and 100 Juniors, a total of about 800. The entrance fees are $5 for members or associates, and the annual dues are also $5. The council passes on applications, which are then submitted to the society; four-fifths of the votes cast will elect. The annual receipts and disbursements are about $8,000; the resources are about $16,000, of which about half is in cash. One meeting is held each year, and the papers and discussions are published in an annual volume of "Transactions."

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—The membership of this society, about 200 at present, is practically all of full grade, Member. The society was organized in 1894 and is steadily growing. Its receipts and expenditures per year are about $2,000, and its total resources at present aggregate about $6,000. The entrance fee is $15, and the annual dues $10. Two meetings are held each year, and

one or two volumes of "Transactions" are published per year.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Organized in 1893, this society has now about 300 members, nearly all being professors of engineering at different American colleges and technical schools. One general meeting is held each year, the proceedings being published in an annual volume of "Proceedings." The annual dues charged are $3. The annual receipts and expenditures of the society are in the neighborhood of $1,000; the resources aggregate about $2,500.

AMERICAN SOCIETY FOR TESTING MATERIALS.—This society was organized in 1898 as a branch of the International Association for Testing Materials, but in 1902 was incorporated under the new name as an independent organization. It has about 225 members, all of one grade. The annual dues are $3, half of which sum goes to the International Association. The American Society publishes an annual volume of "Transactions." Besides the presentation and discussion of papers, the society's work includes the standardization of tests for various materials. The annual receipts and expenditures are each about $500 to $600. The society is governed by an executive committee, which also elects members. The officers are elected by letter ballot for a term of two years.

There are besides the above a considerable number of other national societies devoted to special branches of engineering or the arts closely related thereto, which are in no sense rivals of the four great national organizations and which might well receive the hospitality of a great national engineering society house. Most of these societies hold only one annual meeting a year and choose each year a different place for this. They employ no paid secretary and have no permanent headquarters or offices. Such societies need practically no space in such a building beyond room to store in safety their records and the privilege of a meeting hall when once in a dozen years, more or less, they come to New York City for their annual meeting.

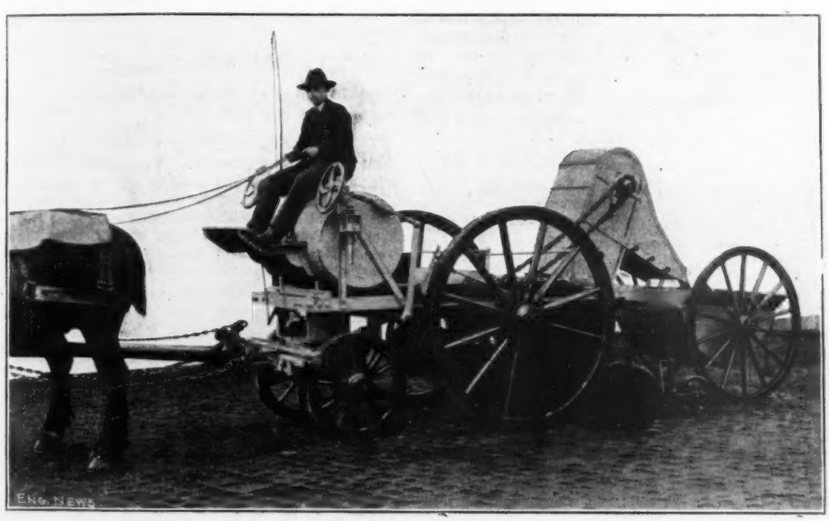
Besides the national societies, there are a number of local engineering organizations in New York City, such as the New York Railroad Club, with its 1,500 members, the recently organized Municipal Engineers of New York, and others which might be named, which need the use of a hall for holding their meetings, usually held at monthly intervals. Some of these societies have for years met in the House of the American Society of Mechanical Engineers, and it is altogether probable that similar hospitality would be afforded them in a Union Engineering House.

It is fair to say also that besides the national engineering organizations, whose national headquarters is in New York City, there are a number of other organizations, chiefly in the railway field, whose natural headquarters is Chicago. The realization of the Union Engineering Building project in New York city may serve to set in motion similar projects elsewhere. A union engineering building in Chicago would form a natural home for such organizations as the American Railway Association, Master Mechanics' and Master Car Builders' Associations, the American Railway Engineering & Maintenance-of-Way Association, the Railway Signaling Club, the Association of Railway Superintendents of Bridges and Buildings, etc. In such a project also would naturally be joined the Western Society of Engineers, the Chicago branch of the American Institute of Electrical Engineers, the Western Railway Club, and doubtless other organizations of similar character.

As for the co-operation of the various local engineering, architectural and scientific societies in the smaller cities in the joint rental of houses or halls for a common headquarters, this movement is already under way, and has been commented on in these columns.

A GERMAN PICK-UP STREET SWEEPER WITH ITS OWN SPRINKLER.

Within the past two years or so a pick-up street sweeper, carrying its own sprinkler, has been brought to the front in Germany. It is said to be in use at Cologne, Antwerp, the Krupp works at Essen, and that one machine has been sold and delivered for use in England. A good general idea of the sweeper can be obtained from the accompanying view, reproduced from a photograph kindly sent at our request by the manufacturers, the Salus Strassenkehrmaschinen Ges, 8 Kaiser Wilhelmstrasse, Düsseldorf, Germany.



A GERMAN PICK-UP STREET SWEEPER WITH ITS OWN SPRINKLER.

The sprinkling tank is mounted beneath the driver's seat. The broom is shaped something like a flattened V, causing the sweepings to gather at the center, where they are thrown on a sliding platform, from which they are taken to the dust cart by means of a bucket conveyor. The mechanism is driven from the main axle, by means of cog wheels and chains. Small detachable carts may be used, or large ones permanently secured to the sweeper.

THE DEVELOPMENT OF ELECTRIC STATION POWER PLANT.*

By Elihu Thomson.†

In 1878 the electric station had its beginning, when a number of dynamos of the alternating type were belted to steam engines and used for lighting the Place de l'Opera and Rue de l'Opera in Paris. The practice of belt driving, in which the dynamo speed is much higher than the engine speed, was well-nigh universal for a period of ten to fifteen years thereafter. The earliest machines which were direct-connected to the engine were probably the Edison "Jumbo" dynamo and the Gordon alternator, both brought out in 1883. The machines up to that time were of very limited capacity. A dynamo that would use 25 to 50 HP. to drive it was one of large output.

The movement toward direct connections was simultaneous with a great increase of capacity over the then existing machines. The Edison Jumbo was a direct-current, constant-potential dynamo of about 1,200 16-c.p. incandescent capacity or about 100 KW. in output. The Gordon alternator was a revolving field machine, the field being about 8 ft. diameter, revolved by the engine direct (and forming a flywheel for the same) at a speed of from 140 to 180 revolutions per minute, the periodicity being about 45 cycles. Its capacity was about 5,000 incandescent lights, or roughly, 350 KW. output. The Armington & Sims engine which drove the Edison "Jumbo" was specially designed to secure relatively high speed, so as to meet, as far as possible, the dynamo conditions. Later on, these same high speed engines were extensively employed in electric stations belted to dynamos running from 600 to 1,500 revolutions per minute, and employed for incandescent or arc lighting in small units.

The example of direct connection gradually spread and the direct-connected electric plant has at last almost entirely displaced belt driven machines. The growth was rather slow, and less rapid in the United States than in Europe. There was, of course, much work to be done in perfecting details, and the substitution of the large direct connected unit for belt driven types may have been retarded by the exceedingly rapid development in various electrical fields.

The replacement came about partly on account of the increasing output, not only of the stations but of the units themselves, up to 5,000 or 6,000 KW. each in some large generating stations to-day. As the size of the unit increased, the speed, of necessity, came down to accommodate the heavy reciprocating steam engines employed. This, however, so far as the dynamo was concerned was only to be accomplished by the use of very massive machines. The dynamo machine and other electric machines are essentially high-speed machines, and any straining for low speed must always be paid for in excess of material or diminished efficiency, or both. Nevertheless, the direct-connected, slow-speed machines of sufficiently large capacity has proved very satisfactory in practice, and has become almost universal. Still, engineers have not been content, and it seems as if we are on the eve of another decided change. In some cases in cities, the vibrations caused by reciprocating engines has, in fact, forced a change in the character of the motive power machines.

Instead of bringing down the dynamo to steam engine conditions, we now bring the steam engine to dynamo conditions by changing the type of engine employed. In fact, the new problem is to bring down the turbine engine, with the excessive speed required for economy of steam, to such speeds as are within the range of feasible dynamo construction. It is now about 12 to 15 years since the Parsons turbine was applied to drive direct-connected dynamos of small capacity. The earliest of these ran at about 10,000 turns per minute, and really presented the difficulty that the speed was far in excess of reasonable dynamo speeds. The thing had, in fact, been overdone. Growth in size of units and perfection of design allowed the speeds to be lowered to about 3,000 turns in moderately sized units, and still lower in the largest units, thus adapting the speed to a proper proportioning of dynamos.

The lower limit of speed depends on the size or capacity of the turbine engine, but it will probably not go much below 500 turns per minute, even in the largest units. In the DeLaval turbine, the construction is such that reasonable speeds for dynamo work are only to be obtained by a remarkable development of reducing gear. In such a case the plant becomes no longer direct-connected. In the Parsons form of turbine the steam entering at one end over the whole wheel and passing in succession sets of vanes carried thereby and stationary vanes or guides alternating therewith, progressively expands until it reaches the exhaust end. In the DeLaval, the expansion takes place in a nozzle or set of nozzles directed against the vanes of a portion of the periphery of the vane carrying disc. The form of jet or nozzle is flaring toward the wheel, and the conversion of the kinetic energy of the steam into motion in one direction takes place in the expanding nozzle itself and the fall of temperature and pressure therefore occurs largely before the stream reaches the wheel, which itself revolves in a fairly good vacuum provided by the condenser.

In the lately developed form of turbine due to Mr. Curtis, the work of the steam is divided into distinct stages, part of the expansion taking place definitely in each stage, and part only of the periphery of the wheels being acted on by the jets or by steam pressing in the intermediate guides. The action of compounding is somewhat analogous to that in a compound engine in which the turbine wheels of the successive stages are taken to represent the succession from the high pressure to the lowest pressure cylinders. The efficiency of the turbine engine depends in large measure upon its exhausting into a vacuum. The condenser is therefore a very important auxiliary.

*Abstract of a paper prepared for the annual convention of the National Electric Light Association at Chicago, May 27, 29.
†Lynn, Mass.

In the Curtis turbine, the ability to secure relatively low speeds is shared with the Parsons form, and the ability to govern output by increase or decrease of steam entering the nozzles is shared with the DeLaval form. This latter feature is valuable in governing and in meeting overload conditions. The present intention, however, is not to go into the details of turbine construction. It is rather to point out and emphasize the apparent fact that the low-speed direct-connected unit (the huge generating plant of to-day) must probably eventually yield to the much smaller relatively high speed, and less costly, turbine driven plant. While, perhaps, there will be little if any gain in steam economy at full load, the turbine has the decided advantage that the efficiency curve holds up for partial loads, even far below half-load, particularly when the governing is accomplished as above indicated. This valuable feature is, as is well known, entirely absent in the compound engine of ordinary type, the efficiency curve falling off very rapidly with decrease of load to a point which soon neutralizes all the advantage of compounding. The turbine is essentially a high-speed rotary engine, an ideal for electric machinery, with simple bearings, constant angular velocity, high light load efficiency and light weight. It is particularly adapted to the large units now in use so extensively. The turbine seems destined to play a large part in the future development of the electric power and lighting station.

While it does not promise great gain in steam economy under full load as compared with the reciprocating types, the average result where load changes are taking place will doubtless be that a much better economy is obtained. The gains in original outlay, in space taken up, and in maintenance costs seem to be so considerable as to be decisive as to its adoption.

Looking still further ahead, can we be assured that it is the ultimate step. Laying aside, as improbable, the direct conversion of the energy of fuel into electric energy, inasmuch as we see no promising signs of its possibility; and considering the fact that the cost of fuel will probably advance steadily as our near-the-surface coal supplies are worked out, it would seem that we must perforce at last turn to those forms of prime movers which have inherent possibilities of developing much higher efficiencies in the use of fuel than are existent in the steam engine.

Even at the present day in certain relatively very small units, the internal combustion engine, such as the gas or oil engine, has shown efficiencies nearly double that of the best steam engine plant and the partial load efficiency is also satisfactory. There can also be no question that the internal combustion engine is susceptible of improvement, such that in large units the present efficiency will be far surpassed. It seems even probable that an efficiency of heat conversion up to between 40 and 50% will some day be practicable, a result about three times better than is attained with steam. The engines which would be used would naturally be of large reciprocating type and comparatively slow speed, unless some form of gas turbine be developed, a matter upon which serious doubts may be expressed.

What is meant by a gas turbine is a turbine driven by gas expanding from a chamber in which the gas is burned at high pressure and temperature with the requisite amount of air. Such a machine demands the pumping of the air and gas prior to their combustion. The waste gases are, of course, incapable of condensation in a condenser.

The problems involved in a gas turbine are then altogether different from those of a steam turbine engine, and they are necessarily more difficult of solution. In favor of the ordinary gas engine is the fact that all grades of fuel gas may be used with almost equal facility, and even the poor gas, of very low calorific value, such as is sometimes a waste product of blast furnaces in iron smelting, may be used. Coal dust, culm, and waste of mines of low fuel value may be made to yield gas suitable for feeding gas engines. Liquid fuel, as oil of various grades, is also available, and engines have been run, experimentally at least, by feeding them simply with coal dust itself. The richest fuel, down to the lowest and poorest grade, may therefore be employed directly or indirectly in gas engine work, and a good efficiency, much exceeding that obtainable with any form of steam engine, is even now obtainable, although the units are not very large. Much remains to be done, however, to render the larger types of gas engines equally available with steam engines, and the day of their rapid introduction is probably still far enough away to cause little need for hesitancy in the adoption of turbine plants for electric stations.

Where soft coal is first converted into gas by a gas producer, useful by-products may be obtained which have sufficient value to warrant their being collected and sold. Moreover, the gas may be continuously produced and stored until needed. These conditions are, of course, well known. An advantage obtained from the gas engine, and one which has been frequently pointed out, is the short time required to get it into work and the equally quick shutting down of running expense when it is stopped. Provided only the store of fuel is ready to be drawn upon, there is no expense for fuel except during running; neglecting, of course, interest on plant. A quickly stopped and started gas engine plant can take care of load peaks most effectively and efficiently. But if the gas engine should ever become a general source of power, what becomes of our driving? Will it be brought again to belting or some form of gearing up for increase of speed, or will the heavy direct driven dynamo again be found coupled to gas engines instead of reciprocating steam engines

It is not probable that large gas engines will be run much faster than steam engines of equal power, so that the queries just propounded will need to be answered by future engineering, provided we are right in assuming that the future economical conversion of the energy of fuel into power must come through improvement and increase of size of gas engines.

In the considerations above advanced, the use of water power is purposely neglected. The amount of water power which can be rendered available with economy is limited, and it is fairly local in spite of long distance transmission, while the need of electric generating stations will be more extended and universal as time goes on. The trunk-line railways with heavy traffic will need them, and the replacement of small powers by electric motors is a future business which has only just begun, according to all present indications.

MEETING OF BOSTON MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS TO DISCUSS THE UNION ENGINEERING HOUSE.

Since the announcement of Mr. Andrew Carnegie's offer of one million dollars for the erection of a union building in New York city, to be occupied by the four national engineering societies and the Engineers' Club, many of the Boston members of the American Society of Civil Engineers have discussed the proposition among themselves. In the belief that a fuller discussion and a definite expression of opinion from members in this vicinity would be of aid to the Board of Direction, and perhaps to the Society at its approaching convention, a few of the members issued the following call for a meeting:

Boston, Mass., May 28, 1903.

Dear Sir:

There will be a meeting of the members of the American Society of Civil Engineers residing within about 50 miles of Boston, at the room of the Boston Society of Civil Engineers, 715 Tremont Temple, on Monday, June 1, at 4 p.m., for the purpose of considering and obtaining an expression of opinion upon the question of accepting Mr. Andrew Carnegie's offer to contribute one million dollars for the construction of a union building for the national engineering societies and a building for the Engineers' Club.

As it is desired to obtain a full expression of opinion from the members in this vicinity, those who cannot attend the meeting are requested to express their opinion by the use of the appended form or in such other manner as they may desire, and mail the same to Frederic P. Stearns, 1 Ashburton Place, Boston. It is desirable that this form be used in order that the opinions may be tabulated, and that the replies be received on Monday, June 1. Respectfully yours,

Frederic P. Stearns, Dexter Brackett, Henry Manley, Frederick Brooks, S. E. Tinkham, George A. Kimball, E. W. Howe.

(Mark an X opposite the statement which expresses your opinion.)

1. I am in favor of the acceptance of Mr. Carnegie's offer and the construction of a union building.
2. I am not ready to express a decided opinion upon this question; but with my present information would favor the acceptance.
3. I do not care to express an opinion upon this question.
4. I am not ready to express a decided opinion upon this question, but with my present information would oppose the acceptance.
5. I am opposed to the acceptance of Mr. Carnegie's offer and the construction of a union building.

Pursuant to this call, the following members assembled: C. F. Allen, F. A. Barbour, D. Brackett, F. Brooks, S. Child, J. B. Frizell, J. L. Howard, E. W. Howe, Wm. Jackson, H. Manley, W. T. Pierce, D. Porter, L. F. Rice, C. W. Sherman, J. P. Snow, O. Sonne, F. P. Stearns, S. E. Tinkham, E. K. Turner, F. O. Whitney, M. W. Cooley, G. Bowers, E. J. Bengler, J. N. Ferguson, J. C. Moses, S. E. Thompson, J. R. Worcester, C. F. Taylor, G. A. Carpenter, D. M. Wheeler, J. K. Freitag, P. C. Barney

The meeting was called to order by Mr. Stearns, who called attention briefly to the reason for the meeting. Mr. Henry Manley was elected chairman, and Mr. S. E. Tinkham, secretary.

Mr. Stearns announced that 172 notices of the meeting had been sent out; and at that time 75 replies had been received, as follows:

Answer No. 1.....	33	Answer No. 4.....	6
" " 2.....	26	" " 5.....	4
" " 3.....	6	Total.....	75

A letter was read from Lee Treadwell, of the Portsmouth Navy Yard, who favored the acceptance of the offer. He said that much of the objection seemed to arise from the mistaken idea that an acceptance carried with it the merging of the identity of the society with the other societies.

Another letter, opposing the acceptance, was read, from F. S. Curtis, 4th Vice-President, N. Y., N. H. & H. R. R. Mr. Curtis' idea seemed to be that the Am. Soc. C. E. had much to lose and little to gain by such a federation.

City Engineer Wm. Jackson, of Boston, the only director of the society present, said that the subject had only been discussed informally in the Board of Direction, and that with the exception of those who attended the conference, the directors had no more knowledge of the scheme than the membership at large; personally, he was opposed to acceptance. The Board has no authority to settle the question, and it would come up at the convention in a few days.

The resolutions prepared at the conference of representatives of the societies were read. Other members who spoke were: E. K. Turner, J. P. Frizell, J. P. Snow, E. W. Howe, J. K. Freitag, L. F. Rice, F. O. Whitney, F. P. Stearns, D. Brackett, C. Frank Allen, S. E. Thompson and Henry Manley. A letter from Prof. Geo. F. Swain, a Director of the Society, favoring the project, was read. It was voted that the secretary transmit to the Board of Direction a copy of the record of the meeting, with a statement of the vote on the acceptance of Mr. Carnegie's offer. At the close of the meeting, when those present had voted, the count was as follows:

Answer No. 1.....	45	Answer No. 4.....	7
" " 2.....	31	" " 5.....	9
" " 3.....	7	Total.....	99

Or 76 voted in favor, and 16 against, the acceptance of the offer.

THE USE OF BITULITHIC PAVEMENT on Seventh Ave., between 112th and 120th Sts., New York City, has been enjoined by one of the lower courts as a result of a suit brought by the Barber Asphalt Paving Co. The court held that the specifications under which bids for the work were invited limited bidders to the use of a patented pavement, which is in violation of the city charter.

AN AGRICULTURAL MAP of the United States is being made for the St. Louis Exposition. It occupies an area of 240x480 ft., a belt of blue grass lawn establishing the coast lines. The boundary lines between States are marked by cinder paths 3 ft. wide, so that visitors may walk about upon the map itself and see the principal agricultural products of each State growing upon the "map" in their proper places—the cereals in the Northwest, oranges in Florida, tobacco in Kentucky, and so on.

THE UGANDA RAILWAY in Africa was commented on as follows by Mr. Herbert Samuels, M. P., in a recent lecture before the London Society of Arts:

This line is a Uganda railway in name, but in name only. It does not enter, and it is not designed to enter, the Uganda Protectorate. Its entire length lies within the boundaries of the Protectorate of British East Africa. Starting from the fine harbor of Mombasa, on the East African coast, it runs in a west-northwesterly direction for 580 miles, until it reaches the shore of the Victoria Nyanza at a spot in the neighborhood of Kisumu, which now bears the name of Port Florence. From this place it is a two-days' voyage across the lake to Entebbe in the center of the Uganda shore.

Mr. Samuel referred to the cost of construction as undoubtedly excessive. It was estimated to cost under £2,000,000, yet Parliament has been called upon to vote nearly £6,000,000 to complete it. It is true that there have been many difficulties which were unforeseen by the framers of the original estimate; engineering difficulties, difficulties in obtaining labor, difficulties in the supply of water, and an increase in the cost of coal. But the fact remains, when full allowance has been made for these, that the claims of economy have been regarded somewhat lightly by the Foreign Office Committee and by the engineers who have been charged with the construction of this line.

I state this not as an opinion founded on my own observation, but I was fortunate in having opportunities for discussing the question with a number of Europeans in East Africa and Uganda; and the universal opinion of those on the spot is that there has been frequent extravagance in the methods of construction, that unnecessary works have been undertaken, that many mistakes have been made, that there has been much laxity of financial control in matter of detail. From none of those whose views I ascertained did I hear a contrary opinion. But no one who is acquainted with the circumstances can in fairness fail to bear testimony that, open as are the constructors of the railway to criticism on this ground, they are nevertheless entitled to no small measure of gratitude from the country for the successful completion of this great national undertaking, carried out in a country previously almost unexplored, and accomplished in defiance of many formidable obstacles.